SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SCIENCE AND INVESTMENT[1]

INTRODUCTION

THE influence of science upon the investment of capital and the employment of labor in productive enterprises is far from receiving its due recognition in systematic economics. There is a vague sort of knowledge that science and productive industry are related much as a handmaid is related to a household. One looks in vain, however, in any of the standard treatises on economics for anything like an adequate appreciation of the place of the natural sciences in that all-engrossing and highly standardized process of production and exchange which makes up the modern system of industry known as capitalism.

One reason for this lies in the fact that the line of approach of the professional economist to the existing system has been by way of politics or philosophy—by inexact and speculative methods, rather than by the more exact methods of experiment and verification. The bias of approach has left its mark in the inconclusiveness of economic discussion, in the lack of agreement as to what is settled and what is not, and even in the question as to what the real scope and aims of economics are. Under the term "progress of nations" we include a complex group of forces. When we come to weigh them out one by one, it will appear that the greatest motive force in the

[1] Address of the retiring vice-president of Section I at the Baltimore meeting of the American Association for the Advancement of Science.

unfolding of material power in modern times has been that of the various sciences. In fact, it is this leavening of our western civilization with the knowledge and power of the natural sciences, in their mastery over the forces of nature in the service of man, that, more than any other single criterion, marks off modernity from all that goes before it.

SERVICES OF GEOGRAPHY AND ASTRONOMY

Historically speaking, the earliest of modern sciences to affect the nature and scope of investment was geography. The European explorations and discoveries of the fourteenth and fifteenth centuries added an area of territory to the field of commerce, probably three times the size of that known to western Europe prior to the rounding of Africa, the opening of a sea-route to India, and the discovery of the American continent. Then followed the formation of the great trading corporations, of which the East India Company was typical. These corporations broadened out into the colonial policies of western Europe, in the effort to exploit the lands thus discovered for the enrichment of the home countries. Thus in the short period of a single century the map of the entire world had changed, almost beyond recognition—all because the science of geography had enabled the researchful spirits of those times to pass from the confines of the known out into the unknown.

The next of the sciences to influence the progress of modern investment was astronomy. It was by the aid of the science of the heavenly bodies that ocean navigation was rendered possible. It is not too much to say that the annexation of the oceans to the world's area of free enterprise was, next to the discovery of America, the one thing that had most to do with making modern nations what they are in things material. On this basis of maritime traffic, nine tenths of the world's international trade rests. The sea is as vital to Great Britain, and nearly as vital to the national life of Germany, as food is to the body. And yet, without the contributions of astronomy the commerce of the world, which normally among the nations exceeds $25,000,000,000 a year, would be little more than a coasting trade, whose vessels hug in fear the shores of inland seas and the ocean frontages of their own countries.

These two sciences—geography and astronomy—together put into the hands of man the powers whereby he, within a comparatively short period of time, enlarged the extent of the world's market by three times its earlier area and taught men the art of mastering maritime transportation, thus connecting the world's continents by highways over a field of intercourse covering three fourths of the area of the globe. These sciences, when yet in their infancy, laid the foundations of the commercial, industrial and financial powers whose wealth has since assumed proportions so colossal as to stagger the vividest imagination.

METALLURGY AND THE RÉGIME OF MONEY

The next group of sciences which have radically influenced the course of modern enterprise and investment is that which includes the production and the manufacture of metals. Mining and metallurgy put the old world in possession of the precious metals of the new. The infusion of metallic money in such unheard-of quantities into the economic life of Europe was one of the most revolutionary forces that ever came to any age. There was not a single institution, social relation or business contract that did not undergo radical transformation, by virtue of the effect of the precious metals upon the laborer and the employer, the state and the subject, the debtor and the creditor. The precious metals put the monetary systems of the na-

tions on a metallic basis and thus for the first time gave to them a common standard of international value.

Thus far the three distinct contributions of the sciences to the economic factors that go to make up the modern world market are: (1) The discovery of new lands, (2) the utilization of ocean transportation—the cheapest known and (3) an international standard of value. These three things have determined the plane on which investment activity in its most comprehensive scope is still working out its various problems under the guidance and direction of the sciences of geology, chemistry, physics and engineering.

SCIENCES IN SELECTION AND SUBSTITUTION

Possibly the most signal contribution of geology to the advance of investment is seen in the service which national and state surveys render to the development of natural resources. Each of the American commonwealths now regards such an inventory of the earth's formations and composition as geology alone can give as the indispensable condition of inducing capital to seek profitable employment within its borders. Investment of to-day is itself specialized in such a way that it depends upon the specialist's most complete researches to ascertain beforehand the wisdom or the unwisdom of putting capital of any given amount into an enterprise, as well as of locating it with due regard to the assemblage of the materials of production and to the expenses of marketing the products. Geological data determine in large part the answer to these questions. The state survey of the clays of New Jersey decided the location of a large pottery works at the city of Trenton —a point which had ample beds of the chief raw materials, but which also had the advantage of being half way between two cities of over a million population, yet not a hundred miles apart.

Thus the sciences, besides encompassing the globe to determine where nature has hid her treasures, determines where lines of transportation shall be laid down, where population is destined to concentrate, and in what particular channels of employment both labor and capital may find the maximum returns. In other words, science is a function of economic progress, operating under the law of substitution. According to that law, the fall of the rate of profits impels the producer of commodities to find some less expensive substitute among the articles that make up the elements of the cost of production. In the other direction, the making of extraordinary profits may effectively impel the producer to escape the limitation of supplies which keep him from entering on large-scale production, thus multiplying his profits manifold. The burden of discovering what might serve as economical substitutes falls upon the scientific laboratory.

EVOLUTION OF MACHINE INDUSTRY AND TRANSPORTATION

The chemical and physical laboratory constitute the experimental and exploring arm of the up-to-date industry. The railroad must have it to test its materials. The manufacturer must have it to insure himself, not only against deliveries of inferior materials in contract, but even more so to enable him promptly to test the applicability of any new discovery to his business, to decide as to whether or not there is any advantage to him in changing his methods, and to put to test his finished product before it is sent out, thus detecting any defect in construction which actual use might disclose.

Not only has science made industry and commerce more technical, calling progressively for a more highly skilled and a more varied class of labor and talent, but it has without doubt been the chief factor in differentiating modern industry and com-

merce from the handicraft state in the one case and from the primitive forms of transportation on the other. I put it approximately near the truth in saying that machine industry, meaning all work done by mechanical power, would have been impossible but for the use which has been made of physics, chemistry and mechanics in the evolution of the modern system of production and commercial distribution. These three sciences, for instance, share the honor of achievement in the development of the steel rail on our railroads, from the strip of soft iron strung on a pair of parallel girders to a self-sufficient iron rail resting on cross-ties, into the present-day steel rail weighing 100 pounds to the yard. Here we have chemistry, physics, mechanics and metallurgy working conjointly toward an end, which has in turn become the point of departure for a series of developments in the more economical handling of freight. Cutting down costs and increasing carrying capacity have followed the path along which the sciences have led at every stage, in a railway system now representing an investment of $20,000,000,000 in the United States alone.

ENGINEERING AND PUBLIC SERVICE

I need hardly remind you that the most rapid strides among investment activities have indeed been made by those in which science has had the largest sway. These are the fields in which engineering has applied the sciences to profitable uses. One's mind naturally turns to the various enterprises in which electrical power has a domain of its own. Communication, illumination and transportation—three fundamental necessaries of modern living have opened fields of almost unlimited investment possibilities. In all of them, whether it concerns the telephone or the lighting and power problem, the lines of responsible relations with the public are being gradually lain down on safer bases. The popular appreciation of mutual approach to common understanding has already been developed in scores of public service corporations, far beyond the needs of public subscription to capital requirements. The very faith aroused in the soundness of these agencies is an asset of no mean significance in proving the profitableness of their investments.

SCIENTIFIC BASES OF LARGE-SCALE INDUSTRY

It is not usually recognized that science puts a premium on the large-scale industry as compared with the smaller undertaking. The latter can not always afford the expense of maintaining experimental work. The advantage would even be doubtful if it could. But with the consolidation of industries under a central management, the scope of scientific possibilities becomes immensely enlarged. Experiments which demonstrate better results for one plant can immediately be appropriated by all. By the exact measurements of methods and results in one establishment the efficiency of all the others can be tested. This indicates one of the ways in which the sciences have contributed toward the concentration of control and the enormous capitalization of the industrial combinations known as the trusts.

Science in this case pointed out the enormous wastes of so large a number of independent establishments, and helped to measure the extent of economies possible under unified control guided by scientific foresight. We may regret the resulting change. We may even fear for the future of popular welfare in a régime of apparently impregnable combinations. But one thing is sure as fate—and that is this: So far as these consolidations are founded upon scientific bases and remain there, their origin, development and future are assured. But so far as they have had an

artificial and unscientific conception, say in the greed of monopoly, and have vaunted themselves with pride of power unbalanced by the laws of nature, to that extent have they implanted in them the seeds of economic death.

Darwin tells us that for survival two factors are necessary—continuity of type and adaptation to the conditions of existence. Now the work of science in the world's evolution of the type of industry which makes for the maximum general welfare is to increase the degree of adaptability so that the historic type may have the greatest facility of adjustment to actual and prospective needs. Size is the condition of survival. But size uncemented by the scientific spirit, unchartered on the sea of enterprise by the directing captaincy of research, is either doomed to wreck or dry rot. The rise of the corporation, in which form free capital now seeks its widest investment, is the outcome of a search for a type of industrial organization in which the science of the laboratory and the savings of the people may be incorporated under responsible management.

FOUR CRITERIA OF CORPORATE SURVIVAL

This brings me to the point of stating the criteria of survival and development to which the modern business corporation must conform. For I think we all recognize that, although under corporate form, the western world has made unparalleled progress in investment, still the main purposes of investment, namely, personal profit and popular well-being, will not, at this stage of the world's democracy, consent to sacrifice the latter wholly for the former. The corporation will survive only as it serves its function of economic progress, both by being a better producer of wealth out of natural resources and by being a better distributor of wealth, once created, as a product of the unified resources of the community. In short, the corporation as an investment institution gathers into itself the surplus resources of the people, on the at least implied promise of bringing them better returns for its use than they can win working alone. The fulfillment of that obligation, whether regarded as moral or legal, is possible only on condition that it meet to a reasonable degree four distinct criteria of business experience.

Investment within each particular field must no longer hazard the certainty of the outcome on individual management divorced from contact with those who furnished the means necessary to bring labor and capital together under responsible control and cooperation. That business management of entrusted capital may enjoy the certitudes of regular returns it must rest upon scientific, not individual, foundations. Thus will investment of popular savings be lifted out of the boggy ways of speculative risks and be raised to the level of demonstration.

First of all, then, the type of investment institution that will meet modern conditions of existence must be *scientific,* in that it must follow the path of demonstrated safety as marked out by scientific research. Secondly, the management of such an institution must be a *responsible* one, in the sense of being morally and technically aware of its rights, duties and possibilities. Thirdly, under existing scarcity of capital the world over, and with the prevailing degree of dependence upon the comparatively small investor, the type of investment organization which prevails will have to be *popular.* It will have to appeal to the confidence of the people effectively enough to draw from them necessary capital, not only for initial investment, but for subsequent doses for extension and development. Fourthly and finally, it goes without saying, that any investment agency

which popular judgment will not destroy will have to be *profitable.*

JOHN FRANKLIN CROWELL

A PLEA FOR TERRESTRIAL AND COSMICAL PHYSICS[1]

ONCE upon a time, at a certain small dinner-party, the Duke of Wellington, on being urged to express his opinion frankly of the French marshals he had so successfully worsted in battle, pointed out their good qualities in a most free and magnanimous manner, showing wherein each particularly excelled. Whereupon one of the party said: "Well, sir, how was it that with such various great qualifications you licked them all, one after another?" The duke, taken back, paused, then said: "Well, I don't know exactly how it was, but I think if any unexpected circumstance occurred in the midst of a battle which deranged its whole plan, I could perhaps organize another plan more quickly than most of them."

This power of being able to instantly change an established train of thought, or to be receptive to a new set of circumstances and facts, and thus to be capable of immediately setting up a fresh plan of action, was tersely and most suggestively expressed by Maxwell. When writing Herbert Spencer about a subject of controversy in the latter's "First Principles," he said:

> It is seldom that any man who tries to form a system can prevent the system from forming around him, and closing him in before he is forty. Hence the wisdom of putting in some ingredient to prevent crystallization and keep the system in a colloidal condition.

At the Ithaca meeting of the association, two years ago last summer, I prefaced a paper on the San Francisco earthquake by a few remarks calling attention to the disparity of papers pertaining to the physics of the earth and of the universe presented to-day before sections A and B. I stated it was my impression that this had not always been the case. Attend any similar meeting abroad, be it in England, Germany or France, and you are apt to find the names of foremost physicists down for papers on results of research in terrestrial or cosmical physics. These eminent investigators evidently find food for exhilarating thought and stimulating work in the unraveling of the phenomena of seismology, meteorology, geodesy, hydrology, atmospheric electricity, solar physics, terrestrial magnetism, etc. They appear to regard knowledge gained in the laboratory and in the university merely as a means to an end, not an end in themselves.

The chairman of the Section of Mathematics and Physics at the recent meeting of the British Association was the well-known physicist-meteorologist, Dr. W. N. Shaw, director of the London Meteorological Office. Besides making a most suggestive presidential address, he led an interesting discussion on "The Isothermal Layer of the Atmosphere"—a live topic in meteorology to-day. Those taking part in the discussion were: Shaw, Rotch, Dines, Cave, Turner, J. J. Thomson, Walker and others. Several times has it occurred within recent years at that association, that, owing to the number of titles presented, it was necessary to have a subsection on "Cosmical Physics" which I am very glad to note did not apparently meet with the favor of the physicists themselves. Our British colleagues want the cosmical physicists to stay with them and not flock off by themselves, and the present tendency seems, accordingly, to be at the British Association, not to form such a subsection. Indeed, Dr. Shaw, in the address referred to, said:

[1] Presented at the Baltimore meeting of the American Association for the Advancement of Science, at the general interest meeting of the Section on Physics, December 30, 1908.

For the advancement of science in this sense we require all three—the professor with academic freedom, to illuminate with his genius any phenomenon which he may be pleased to investigate, the administrator, face to face with the practical problems in which science can help, and the living voice which can tune itself in harmony with the advances of science and in sympathy with the needs of the people whom it serves.

You will find among the past contributors to papers and discussions on the subjects mentioned, such names as, Kelvin, Rücker, Schuster, Lockyer, Eliot, Cortie, Teisserenc de Bort, Glazebrook, Chree, Gill, Thomson, etc.

I can not better illustrate the mutual help that may spring from friendly conference between the pure physicist and the world-inoculated one than to quote you a paragraph or two from a most admirable presidential address delivered by Dr. S. Weir Mitchell, at the second meeting of the Congress of American Physicians and Surgeons, held at Washington in 1891, entitled, "The Early History of Instrumental Precision in Medicine." Referring to this congress of the eminent of the land in medicine and surgery, Dr. Mitchell says:

It is here, therefore, that the open-minded man may feel the broadening influence of intellectual contact with those who have other limitations than his own; for, indeed, in our divergent attention to special studies we run some risk that, contrary to St. Paul, the eye may say to the hand, "I have no need of thee," or the head to the body, "I have no need of thee," for as to us also, there should be no schism in the body. . . .

What the specialist learns, until it is commonplace, is not easily enough assimilated by the mass of practitioners. At last, however, comes a time when it is, and then that whole body of medicine feels the gain in nutrition and repays the debt. The masters of our still most perfect art, medical optics, may wisely remember that it was physicians who most distinctively recognized and diffused the knowledge that headaches and some other brain disorders are due to eye strain, and thus, while lessening our own futile labors, crowded the waiting room of the ophthalmologist. . . .

As I have mentioned the need for continuous individual cultivation of our multifarious science on a broad scale, and for personal consultation, I like to enlarge the plea and call a meeting like ours a general consultation. And this, in fact, it is; a focal point for condensed opinion, for authoritative statements, for criticism from varied standpoints and for significant indications as to those accepted gains which ought to become, from time to time, a part of the mental equipment of all other special, and indeed of all general practitioners.

Change the words physician, surgeon, medicine, to corresponding ones applicable to this gathering, and what apter or truer characterization of what our own aims and purposes should be could be given than is embodied in these words! One is tempted to wish that we might also, like the "Deutscher Naturforscher und Ärzte Versammlung" of Germany, gather with us in annual conclave the physicians and surgeons as well. Picture to yourselves the opportunities this would afford for enlivening and quickening discussions in several of our sections, and you will appreciate what I am seeking to emphasize, especially here, with regard to open, general meetings between the generalist and the "broadened" specialist. I say "broadened specialist" advisedly, for I believe upon critical examination it will frequently appear that the very pursuit of a speciality has a widening influence not adequately appreciated by one whose sphere of activity is restricted solely within the bounds of his own general science. For there is no more patent and suggestive fact of present-day research than that the most notable and the most rapid achievements are not in the older, well-recognized sciences, but in their borderlands or "twilight zones." Thus the true research worker soon finds it necessary to make excursions into regions beyond what he had been regarding as his own particular zone. He makes new acquaintances, learns new customs and laws and gradually begins to

perceive that there really is no well-defined line of demarcation—like the famous Great Wall of China—between one science or another!

One of the recent fundamental researches on the "Motions of the Moon" has been made by a college professor who, though an American resident, got his chief training and inspiration at Cambridge, England. This same investigator has contributed articles on meteorological mechanics. Columbia University, in its admirable endeavor to present a popular course of lectures on subjects of applied physical science, must draw for its lecture on "Atmospheric Phenomena and Physical Theory" upon another foreign-born, Cambridge-inspired, now American resident mathematical physicist. There are several of you here whose work lends additional eloquent testimony to the broadening and cosmical influence of that eminent school of physics. However, there are other European departments of physics of which much along similar lines could be stated and exemplified. Is it not possible to have more home-inspired university product of our own to draw upon in these fields? Shouldn't we strive that our country be adequately represented on international committees formed to consider and to investigate some of the great world-wide questions? I believe we do not lack the talent. If there is less incentive among us, why is it?

The fact I wish to emphasize is strikingly shown by glancing for a moment at the general character of the programs presented in the first two decades of the association's history before the section on general physical science. The papers classified under physics of the globe, meteorology, geodesy and navigation, frequently exceeded those in physics, chemistry, mathematics and astronomy, whereas now, as you all know, they are in a minority. Among the authors of the first-named papers we find names which as soon as heard you will identify as among the most distinguished of the college professors of the middle of the last century: Redfield, Bache, Olmsted, Coffin, Alexander, Henry, Silliman, Peirce, Loomis, Espy, Horsford, Guyot, Lovering, Dana, Trowbridge, Mitchell, etc. Among the more eminent of those occupying government positions we find again Henry and Bache, and such men as Maury, Davis, Hunt, Hilgard, Schott, etc. The mental grasp of many of these geo- and cosmical physicists was considered sufficiently broad to make them desirable timber for the highest positions of honor in the association.

In those "good old days" some of the best contributions in meteorology and terrestrial magnetism were made by the college professor. Bache made a magnetic survey of Pennsylvania early in the forties while still a professor at Girard College, where he also established the first magnetic observatory in this country. John Locke, the inventor of the electro-chronograph (which, by the way, is unique in the history of science in this country as being the only scientific invention, I believe, receiving an award from our Congress, viz., $10,000), in the thirties and forties undertook a magnetic survey of North America with Cincinnati as a base station. He even extended his investigations into Canadian territory and made many of the early observations of the three magnetic elements in the eastern states. Locke was a contemporary of the astronomer Mitchel, holding the chair of professor of chemistry and pharmacy at the Ohio Medical College. He lived at the time when the college professor frequently had to acquire his instruments of research and pay the expenses of his experiments out of his own meager salary. Yet he found ways of doing it and, moreover, had the necessary time to

go beyond his class-room and extend his good work in the territory round about and far away.

Loomis's work on the aurora borealis is still quoted. The contributions to meteorology by Espy, Redfield, Coffin, Maury and Loomis are even known to those of us who do not profess to be meteorologists. These few illustrations must suffice for our present purpose.

If the college professor now lacks the necessary time and incentive during the scholastic year, let him follow the example of Locke, Bache or Nipher who spent their vacations in the open in order to learn something of the physical laws governing natural phenomena. Let him behold his colleagues abroad like Rücker and Thorpe —one a physicist, the other a chemist— who jointly made a magnetic survey of the British Isles during their vacations with the aid of grants which probably just covered expenses and with doubtless no remuneration. The eminent Japanese physicist, Tanakadate, is another instance in point.

Why is it that, in spite of the truly wonderful spirit of research that has literally *seized* us in this country, there are so few of us entitled to be enrolled among those who are making definite contributions to terrestrial and cosmical physics?

We note with pleasure that the American physicist is very prominently represented, indeed, in astronomy and astrophysics. May we not hope that he will soon realize that this planet on which we dwell, and which must form the basis of all our astronomical speculations, is also worthy of the highest and most unselfish devotion? That, indeed, to reap the full and most lasting benefit of our celestial researches we must keep equal pace with our terrestrial ones? Let him recall that nearly every one of the great physicists has at one time or another extended his mental vision beyond the problems immediately before him and considered what the application of his laboratory discoveries might be towards solving some of the riddles of the universe, or how he might benefit mankind. Faraday, Maxwell, Kelvin, von Helmholtz, Hertz, Mascart, Langley and Rowland are but a few of the inspiring names.

Happily, there are already some indications of a reawakening, and we note with pleasure the example recently set by our retiring president, who turned his sabbatical year to fruitful use in the study of some perplexing atmospheric phenomena. We note movements at some of our large universities to expand their graduate courses in the direction of the applied science here had in mind. At the present meeting we find 12 papers before Sections A and B, which might properly be classified under terrestrial and cosmical physics.

Von Helmholtz, as many of you know from actual experience, was a notoriously poor lecturer. He seemed utterly incapable of imparting his vast knowledge in any systematic manner, and doubtless the chief value which his listeners got was the inspiration imparted by class-room association with this gifted man. Von Bezold, who delivered the Berlin memorial address on von Helmholtz, told me the latter gave as the reason of his inability to impart his acquired knowledge methodically, the fact that he himself had not gained it in that way. He would take up his mathematics, for example, only when he required it— not by going systematically and consistently through a volume of higher analysis without some impelling or suggesting motive. And so it was with the other sciences with which he had to familiarize himself to push to successful completion an intricate and complex piece of research. Yet how

truly marvelous was the grasp this man displayed in so many varied subjects!

Now who has ever attempted to apply his knowledge to fields outside his own immediate one that has not felt this same irresistible, impelling, burning desire to know all that has been done before him in the new country he is about to explore? Haven't we each one of us found that with such an all-conquering impetus back of us the most complex mathematics or the most abstruse subject teems with a new and living interest? What was irksome before has now become a pleasure! And if there is one of you who for lack of excursions into such green pastures has not had new and invigorating blood course through his veins and has not been given a glimpse of a higher, truer and more ennobling vision of life, he has missed the greatest pleasure and the highest compensation open to the research worker!

Do you know of a school of thought that has prevailed for any length of time without resistance to that most subtle and, therefore, most dangerous of all insidious modes of attack, viz., the one coming from within its own fold of devotees, due to the pernicious habit of in-breeding? Is there any greater danger than that which besets a university which fills its chairs repeatedly from among its own graduates? We all know of the fallacy of the brilliant professor who thinks his ideas can be made to continue longest by surrounding himself with assistants drawn, if not entirely, at least chiefly, from among his own disciples. Will he not surely find, as Maxwell put it, that his "system has closed him in before he is forty" because he has forgotten the essential element to prevent crystallization —the importation of fresh blood and the introduction of new ideas?

If you agree with the speaker thus far, may not similar occurrences be recorded of our societies, because of the suicidal policy of a particular class of members who are apt to believe that the best result can be reached by increasing their representation, and thus by their majority vote be able to dictate and control the general policy of the society to which they belong? Is it wise organization for membership in any deliberative body to be so constituted as to make it possible for the act of the assembly to be unduly influenced by one set of investigators? Is there not here subject for careful thought—a source of degeneracy due to the in-breeding in societies to be equally guarded against? Joseph Henry truly said: "Votes in science should not be counted, but *weighed!*"

This then is my specific plea: a broader conception and a more scientific representation of the subjects of physical research. Could we not make the attempt certainly once a year to devote most of our time and attention to some of the greater aspects of our work and take stock, so to speak, of our achievements, and of their possible applications?

L. A. Bauer

REPORT OF THE COMMITTEE OF THE AMERICAN CHEMICAL SOCIETY APPOINTED TO COOPERATE WITH THE NATIONAL CONSERVATION COMMISSION

In May, 1908, a meeting of the governors of the different states was held at the White House in Washington to consider the conservation of our rapidly wasting natural resources. Following this meeting, a commission was appointed by the president of the United States to investigate the subject, and the principal scientific societies of the United States were invited to cooperate with it. The committee of the American Chemical Society, appointed in response to this invitation, now has the honor to submit the following preliminary report.

On December 8, 9 and 10 the National Conservation Commission met in Washington in joint conference with the delegates of

other organizations and the governors of more than twenty states. The commission, in its elaborate investigations, had, so to speak, taken stock of our natural resources, and its report, therefore, was essentially statistical in character. It had estimated the magnitude of each particular resource, and had studied the rate of consumption of such substances as lumber, coal, iron, etc. It discussed the wastage of the land by preventable erosion, and its effects not only upon agriculture but also in reducing the navigability of streams. Questions like these were treated at considerable length, and their general character is all that need be mentioned just here. The data of the commission were mainly classified under four headings, namely, minerals, forests, lands and waters, and under each one the evils to be remedied were pointed out with all the emphasis and clearness which the statistical method of investigation made possible. The commission cleared the ground for study into the prevention or limitation of future waste; and the problem of conservation can now be taken up in a more intelligent manner than has been possible hitherto. We now know better than ever before what the evils and dangers really are; the next step is to discover remedies, and then, finally, to apply them. The public attention has been aroused; the people of the country are awakening to the necessity of greater prudence and economy in the use of our resources, and definite lines of action can now be laid down with a reasonable probability that they will be followed. Fortunately the reports of the commission are neither sensational nor unduly pessimistic; the results of their conferences are presented seriously, and in such a manner as to compel consideration; they are therefore all the more likely to produce permanent effects of great benefit to the American people. The utterances of the mere alarmist rarely carry conviction; but disclosures like these made by the Conservation Commission can not be disregarded.

Up to the present moment chemistry has had little to do with the investigations of the commission. Henceforward the chemist must be called upon in many ways, for the waste of resources is often preventable by chemical agencies. Chemistry has already done enough to prove its potency, and its influence is felt in every branch of industry. Adopting the classification of the commission, we shall find the chemist active under every heading. Under minerals, we must note that metallurgy is essentially a group of chemical processes by which the metals are separated from the ores; a separation which may be either wasteful or economical. Within recent years, within the memory of members of this society, the available wealth of the world in metals has been enormously increased. By the cyanide process for extracting gold, ores are now profitably worked which were formerly worthless, and at the same time the demand for mercury has been decreased. The Bessemer process for steel making, now also modified for use in copper smelting, is purely chemical; and its later modification, the Gilchrist-Thomas process, applies similar principles to phosphatic ores, which were previously of little value. Furthermore, in the last-named process, phosphatic slag is produced, which is useful as a fertilizer and helps to relieve the drain upon our rapidly wasting supplies of phosphate rock. Chemists are now studying, with much success, the problem of preventing corrosion in iron, a research which will prolong the life of iron structures and thereby reduce the waste of ore. The use of coal slack by briquetting methods is largely based upon chemical investigations; the salvage of by-products from coke ovens, such as tar and ammonia, is wholly due to chemical research; coal is further economized by the study of boiler waters and the consequent prevention of boiler scale. Even inferior coals, lignites, are now converted into what is known as producer gas, and so are transformed into the best kind of fuel. Petroleum is refined by chemical means, and every fraction of it is saved, either as illuminating oil, as gasoline, as a lubricant, as vaseline, or as paraffin. These are all notable achievements, but greater are yet to come. Enormous quantities of valuable substances are thrown into

the atmosphere in fumes from smelters, which should, and probably can be, partly saved. Electro-chemistry is rapidly developing a large group of new industries, making such metals as aluminum, magnesium and calcium available for use, and it is reaching out into other fields of electrometallurgy in which electric heat, generated by water power, will be used for smelting other metals, thereby reducing the consumption of coal.

In forestry also, the influence of the chemist is distinctly felt. The sprays, used for destroying noxious insects, are chemical preparations. The manufacture of wood alcohol is a chemical process, which may be either wasteful or economical. Turpentine is now produced wastefully, but the waste can be diminished by careful refining, and furthermore, the chemist can aid in discovering substitutes for it. Substitutes for tan bark are also to be sought for by means of chemical investigations. Another distinctively chemical operation is the preparation of wood pulp for paper making, a process which is now wasteful in the highest degree. It is estimated that for every ton of pulp now made by the sulphite process more than a ton of waste material is allowed to drain away into our streams. How to make this material useful is a chemical problem, and so also, in great part, is the investigation of other, now useless fibers, which may replace the more valuable wood. The preservation of wood from decay is still another art in which chemistry is predominant.

In preserving the fertility of our land, chemistry has an important part to play. Our knowledge of fertilizers, of the food on which crops can thrive, is entirely chemical so far as accuracy is concerned, and must be applied in accordance with chemical principles. A fertilizer which is useless, and therefore wasted on one soil, may be needed on another. Certain fertilizers, like the Stassfurt salts, Peruvian guano, the Chilean nitrates, and phosphate rock are limited in quantity, and their future exhaustion must be considered now. What shall replace them in the future? Already processes have been devised for fixing the nitrogen of the atmosphere and rendering it available for plant food. Saltpeter and other nitrates can be and long have been made from waste materials such as old mortar and animal refuse. The phosphatic slags have been mentioned in connection with metallurgical processes. These sources of fertility are important, but greater still is the source found in our municipal sewage. The problem of its salvage has been worked out in some localities, but in the United States the people are only beginning to be aroused to its importance. Enormous masses of material, easily available for fertilizing purposes, now drain into our rivers or directly into the sea. Another question, now under investigation, is the possibility of using our common feldspathic rocks in fine powder, to replace the potassium withdrawn by plants from the soil. The relations between the chemical composition of water and the conservation of natural resources are of intimate and fundamental importance and some of them have been mentioned under other headings. The rate at which the land surface of the United States is being transported to tide water has recently been estimated by means of chemical analyses of river water coupled with determinations of stream flow, and the results of the computations will doubtless assist considerably in studying soil erosion and the impoverishment of agricultural lands. In steam making the chemical quality of the water supply is an appreciable factor in fuel consumption, a subject to which reference has already been made. The scale that forms on the boiler shell and tubes, when water containing incrustants is used, is a poor conductor of heat and, consequently, causes increased expense for fuel. By detailed study of the chemical composition of available boiler waters, it is possible to select a supply having a minimum amount of incrusting, corrosive and foaming constituents, thereby effecting appreciable economy in fuel. Chemical investigation of methods for purifying water supplies, not only for boilers but for paper manufacture, soap-making, and other great water-consuming industries, will enable man-

ufacturers to make new and greater saving in many raw materials other than fuel.

Stream pollution by industrial refuse and by sewage is a source of enormous waste in our natural resources. The subject has been for many years a field of research for industrial, sanitary and biological chemists in the United States, and their investigations have resulted in the improvement of manufacturing processes, the utilization of wastes, the purification of sewage, and the protection of domestic water supplies. When the presence of deleterious substances in our river and lake waters has caused loss of fish life and the destruction of oyster beds, the chemist and the biologist have detected the harmful ingredients and have suggested methods for their removal. River silt, an important source of detriment to navigation, is also estimated by the chemist. It has been fully demonstrated that the prevention of stream pollution lies not alone through injunctions and other legal proscriptions but also in using waste materials or, when that is not possible, in rendering them harmless. The chemist has much to do in protecting and preserving the quality of our water supply. Upon that, in very great measure, depends the preservation of our highest resource, human life. Polluted waters distribute typhoid fever and other dangerous diseases, and so cause losses which should be, and really are, preventable.

The foregoing illustrations are enough to show, for present purposes, the intimate connection between chemistry and the study of conservation. They also bring out the fact that the classification adopted by the national commission, although admirable for statistical research, is not final, and that it needs to be supplemented by a different subdivision of the data. The facts to be investigated often fall under more than one heading of the classification, and actually interlock in every conceivable manner. To operate a placer mine, for example, abundant water is needed, while a deep mine requires timber for its shafts and levels. In building and occupying a house one covers land, uses lumber, brick, stone, and iron, introduces water supply, and burns fuel. In short, every phase of the conservation question affects the interests of everybody. If the investigation of our natural resources is to be made effective, it must be applied to individual industries, and in order to do that another scheme of classification would seem to be necessary. Such a scheme we venture to outline, but very briefly.

At the outset the problem can be divided into two parts, one relating to sources of energy, the other to material substances. The two are not really separable, but may advantageously be considered separately.

In the first place, the energy available for industrial uses may be classified under three heads, as follows: First, inexhaustible energy, such as solar radiation, wind power, tidal power and, with certain limitations, the power furnished by flowing streams. Second, reproducible or renewable energy, like the power supplied by horses and other domestic animals. Wood, regarded as fuel, also falls under this heading, for forests can be artificially grown. Third, the exhaustible energy represented by mineral fuel, like natural gas, petroleum, and coal, which, once used, is gone forever. Under this classification the practical problems are, to economize the exhaustible energy, to encourage the development of renewable energy, and to discover new methods of using the inexhaustible energy.

Exactly the same classification applies to material substances. Some, like sea salt, limestone and clay are, humanly speaking, inexhaustible. Agricultural and forest products are reproducible, some of them year by year. The metallic ores and such useful minerals as phosphate rock are, however, exhaustible, and need to be conserved.

With the aid of this very simple classification it becomes possible to analyze a specific industrial problem in such a manner as to make evident its factors of waste or economy. For example, sea salt is inexhaustible, and may be extracted by solar evaporation, which is a use of inexhaustible energy. Agricultural products are renewable, and their production chiefly requires the renewable energy of men and animals. But the smelting of

metallic ores, as now conducted, involves the use of exhaustible material both as ore and as fuel.

In most industries, however, the two sets of considerations are combined. Portland cement, for example, is made from inexhaustible substances, but is burned with exhaustible fuel. The latter factor in the industry, therefore, is the one to be carefully considered, while the first factor is negligible. Taking industry by industry we shall find that this condition of affairs is general, and that each one must be studied by itself with reference to its inexhaustible, reproducible and exhaustible elements. In doing this a clear notion can be obtained as to the real needs of a given industry, and our attention can then be concentrated upon those features of it which particularly demand economy. We shall be able to locate evils with greater accuracy; to diagnose the industrial diseases, so to speak, and then to look intelligently for remedies. Many of the remedies must be sought for along chemical lines of research, which will develop economical processes of manufacture, utilize materials that are now wasted, or substitute cheap for costly substances. Cheap and costly, however, are words which need qualification. A substance or a process which is cheap to-day may be in reality wasteful with a temporary reduction in price at the cost of some permanent economy. For our purposes the two words imply a deeper discrimination than is carried by their ordinary use. Temporary efficiency and cheapness are to be discountenanced, while permanent economy for the benefit, not only of the nation but of the whole human race, is to be encouraged. This principle is sound, but its practical applications will involve many difficulties, and develop many conflicts with special interests. Like all ideals it can not be realized absolutely, but it represents a standard of action towards which we must move, even though the ultimate goal of perfection may never be attained. Evils can be mitigated, although they may not be entirely removed.

The American Chemical Society now numbers more than four thousand members, scattered through all the states and territories of the union and represented in every one of our great productive industries. These chemists are at the same time progressive and conservative in their work, for they are both discovering new utilities and protecting old ones from loss. We believe that every member of the organization is necessarily in sympathy with the great forward movement for economy, and that in our society the National Conservation Commission will find a most powerful and willing ally.

F. W. Clarke,
H. W. Wiley,
C. H. Herty,
S. W. Parr,
R. B. Dole

SCIENTIFIC NOTES AND NEWS

The Royal Academy of Stockholm has presented Mr. Thomas A. Edison with its Adelskiold gold medal for his inventions in connection with the phonograph and the incandescent light. This medal is conferred once in ten years.

Professor Cleveland Abbe, of the U. S. Weather Bureau, has been elected an honorary member of the Royal Meteorological Society.

The Alumni Association of Columbia College and the School of Mines gave a dinner to Dean J. H. Van Amringe, professor of mathematics in Columbia University, on April 3, to celebrate his birthday and a half century of teaching at Columbia College. A loving cup was presented to him.

It is announced that President Taft has requested Surgeon General Wyman to draw up a tentative plan for the consolidation under one bureau of the agencies exercised by the federal government for the preservation of the public health.

M. Jungfleisch has been elected a member of the Paris Academy of Sciences in the section of chemistry as successor to the late M. Ditte.

Mr. Charles S. Sherrington, professor of physiology in Liverpool University and Mr. William H. Maw, editor of *Engineering*, are

to receive the doctorate of laws from Glasgow University.

THE Chemical Society, London, has conferred its Longstaff medal on Professor S. F. Kipping, of University College, Nottingham.

PROFESSOR HAROLD DIXON has been elected president of the Chemical Society, London, succeeding Sir William Ramsay.

AT the sixty-second annual meeting of the Paleontographical Society, held in the rooms of the Geological Society, London, on March 19, Dr. Henry Woodward was reelected president, Dr. G. J. Hinde, treasurer, and Dr. A. Smith Woodward, secretary. Sir Archibald Geikie, was elected a vice-president in succession to the late Mr. W. H. Hudleston.

PROFESSOR THOMAS PURDIE will retire at the end of the summer session from the chair of chemistry at St. Andrews, owing to ill-health.

THE Isaac Newton studentship at Cambridge University, tenable to April 15, 1812, has been awarded to Mr. W. J. Harrison, of Clare College.

MR. N. W. THOMAS has been appointed government ethnologist to southern Nigeria.

DR. CAROLINE MCGILL, instructor in anatomy at the University of Missouri, has been awarded the Sarah Berliner research fellowship for women of the value of $1,200.

DR. PHILIP P. CALVERT, assistant professor of zoology in the University of Pennsylvania, will be given leave of absence, and his place will be filled next year by Dr. Merkel Henry Jacobs, who is now engaged in post-graduate study at the University of Berlin.

MR. J. R. JOHNSTON, of the Bureau of Plant Industry, returned recently from the vicinity of Baracoa, Cuba, where he has been engaged for some months in researches on the nature and possible control of the cocoanut bud-rot.

DR. VICTOR C. VAUGHAN, of the University of Michigan, will deliver the presidential address at the meeting of the Association of American Physicians to be held in Washington on May 11 and 12.

DR. A. C. LANE, state geologist of Michigan, gave a special lecture on "The Grain of Rocks," in the department of geology and a talk on the "First Evidences of Life on the Globe," to the Science Club, at the University of Wisconsin on March 26.

AT the meeting of the American Philosophical Society on March 19, Professor Marston T. Bogert, of Columbia University, gave an address entitled "On Coal Tar Products and their Application in the Arts and Medicine," which was illustrated by a large number of specimens.

MAJOR M. W. IRELAND, who is chairman of the committee appointed by the legislative council of the American Medical Association, to assist Mrs. Carroll, the widow of Major James Carroll, announces that $2,500 have been subscribed, chiefly by medical officers of the Army, the Navy and the Public Health and Marine Hospital Service. Though Mrs. Carroll was voted a pension of $125 a month, this does not suffice to support and educate her seven minor children; the aged mother of Major Carroll was also dependent on him. Subscriptions for the relief of Major Carroll's family and as a recognition of his heroic and distinguished services for the suppression of yellow fever may be sent to Major M. W. Ireland, Office of the Surgeon General, War Department, Washington, D. C.

DR. WILLIAM JONES was murdered, on March 28, by natives in the Philippine Islands, where he was carrying forward anthropological work on behalf of the Field Museum of Natural History of Chicago. Dr. Jones, who was partly of Shawnee Indian descent, studied at Harvard University and subsequently took the degree of doctor of philosophy at Columbia University. He was an accomplished anthropologist, and his death is a serious loss to the science of anthropology.

WILLIAM CHARLES KERNOT, professor of engineering in Melbourne University, has died at the age of sixty-four years.

FOLLOWING up the plan inaugurated by the section of geology and mineralogy of the New York Academy of Sciences last year, the mineralogical and geological section of the Academy of Natural Sciences of Philadelphia proposes to arrange for a second annual spring

meeting of the geologists of the northeastern United States, to be held in Philadelphia on Friday and Saturday, April 23 and 24, 1909. It is planned to hold two sessions for the reading of papers, and a field trip to typical localities of the Pre-Cambrian and early Paleozoic rocks of the region. It is hoped that every one will be able to contribute, if not an extended paper, at least an informal account of work being carried on. Titles should be sent to Professor E. T. Wherry, Lehigh University, South Bethlehem, Pa.

On Thursday evening, March 18, Dr. Barton W. Evermann, assistant in charge of scientific inquiry, Bureau of Fisheries, Washington, D. C., delivered a lecture to the members of the Massachusetts Fish and Game Protective Association and their invited guests at the Copley Square Hotel in Boston. His subject was "With Packtrain to the Tip-top of the United States in Quest of the Golden Trout," illustrated by numerous stereopticon slides. When it was reported to President Roosevelt that the golden trout, known only from Volcano Creek in the High Sierra of California, was in danger of extermination, he called upon U. S. Fish Commissioner Bowers to have an investigation made and Dr. Evermann was put in charge of the field party. The golden trout of Volcano Creek proved to be an undescribed species which has been named *Salmo roosevelti.* Another undescribed species was found in Soda Creek, a western tributary of the Kern; and it has been named *Salmo whitei,* in honor of Stewart Edward White, who suggested the investigations. The expenses of the lecture were paid from the income of the "Ivers Whitney Adams Fund," a gift of $5,000 presented the association in 1908, by Mr. Ivers Whitney Adams, of Boston, "to secure and provide lectures to be given before the members of said association at regular or special meetings of each year, but not at annual banquets, said lectures to be illustrated, as far as practicable, and connected with the objects of the association."

The *Geographical Journal* states that in 1907 Professor Eberhard Fraas discovered an interesting fossil bed in the Upper Cretaceous formation of Tendagu, in the Linde district of German East Africa. This deposit contained a number of bones of Dinosaurs, the bones of these huge reptiles lying for the most part in their natural position in the marl and sandstone, from which they have weathered out so that they protrude at the surface. The specimens brought back by Professor Fraas are now mounted in the museum at Stuttgart, and have been shown to belong to a herbivorous Dinosaur which must have reached a length of about 48 feet, and has been named Gigantosaurus. The specimens are incomplete, and so much interest has been aroused by them that the German government has decided to send a special expedition to the region, to examine the deposit in detail, and to make additional collections of fossils.

The honorary secretaries of the Zoological Society of Scotland, which has recently been founded, inform *Nature* that the society has been formed for the purpose of establishing a living zoological collection and garden at Edinburgh. The garden will be arranged on the system adopted by Herr Hagenbeck, of Hamburg, and will be conducted on scientific lines. When the society has developed sufficiently, it is within its scope to establish branch gardens in the other large towns in Scotland. In addition to this, lectures of a popular nature by eminent zoologists will be arranged. The headquarters of the society, and the first and principal garden, will be at Edinburgh. To obtain the necessary capital a garden fund has been opened, to which donations are solicited. The annual subscription is £1 1s., but members who join the society during 1909 pay 10s. only for that year. This will entitle members to all the privileges usual in such a society. The aim of the promoters is to build up a strong society with a large membership, so that a considerable part of the annual sum required for the upkeep of the gardens will be insured from subscriptions, and less dependence will require to be placed on the receipts from the public for admission.

At the regular monthly meeting of the Biological Club of the Ohio State University on Monday evening, March 1, a special program in commemoration of the centenary of the birth of Charles Darwin was presented.

President William Oxley Thompson had consented to act as honorary chairman, but later found it impossible to be present, and Miss Freda Detmers, president of the club, presided. The program was intended to cover the various phases of Darwin's life work as the following list of subjects will indicate: "Darwin's Character and Method of Work," Professor F. L. Landacre; "The Influence of Darwin's Work in Geology," Professor G. D. Hubbard; "Darwin's Contributions to Zoological Science," Professor Herbert Osborn; "Darwin in His Relationship to British Stockmen," Professor C. S. Plumb; "Darwin's Contributions to Horticultural Science," Professor V. H. Davis; "The Work of Darwin in Physiological Botany," Professor A. Dachnowski; "Darwin's Contributions to Botany," Professor J. H. Schaffner; "Darwin and Modern Philosophy," Professor A. E. Davies; "Darwin and Modern Psychology," Professor D. R. Major.

UNIVERSITY AND EDUCATIONAL NEWS

THE appropriations committee of the Pennsylvania House of Representatives has reported a bill recommending an appropriation of $700,000 to the University of Pennsylvania.

IT is said that Dalhousie University is likely to be removed from Halifax, N. S., to the city of Dartmouth on the opposite side of the harbor. This city has offered a free site and about $100,000 for buildings.

THE governor of Colorado has signed a bill permitting the state university to conduct the last two years of its medical course in the city of Denver.

THERE has been introduced in the New York assembly a bill which provides that five members of the board of trustees of Cornell University shall be appointed by the governor, his appointments to be subject to the approval of the senate.

A ROYAL commission has been appointed to consider the position and organization of university education in London.

THE inauguration of Dr. Richard C. MacLaurin as president of the Massachusetts Institute of Technology will take place on Monday, June 7, at Symphony Hall. A committee of the corporation, faculty and alumni has been appointed to take charge of the ceremony.

MR. R. H. WHITBECK, of the New Jersey State Normal School, Trenton, N. J., has been appointed assistant professor of geology at the University of Wisconsin. He will give courses especially intended for the preparation of teachers, dealing primarily with applied geography and with materials available for secondary school teaching and methods of presenting physical geography, geography and geology.

DR. EDMUND LANDAU, docent at Berlin, has been appointed professor of mathematics at Göttingen.

DISCUSSION AND CORRESPONDENCE

CITY BOYS VERSUS COUNTRY BOYS

TO THE EDITOR OF SCIENCE: In your issue of February 12 Mr. W. J. Spillman, under the title "Education and the Trades," makes, with regard to the birthplaces of leading Americans, the following surprising statement:

> I believe there are some things which have higher pedagogic value than anything taught in our schools to-day, else why is it that with only 29 per cent. of our population actually living on the farm, with miserably poor school facilities as compared with our city population, this 29 per cent. furnishes about 70 per cent. of the leaders in every phase of activity in this country?

I say surprising, because any one who is familiar with modern investigations in the inheritance of mental qualities in man, must see that such a supposition, if it were indeed a fact, would seriously clash with the conclusions drawn from a number of researches otherwise harmonious and mutually supporting.

This point I will discuss later, but now let us test the facts. Does the farm produce more than its share of leading Americans? Such a question must be answered on a statistical, impartial, and as far as possible, scientific basis. It is first necessary to determine who are the "leaders in every phase of activity in this country." I have turned to "Who's

Who in America" to answer this question. This book has already been successfully used in several sociological studies, and has great value as a starting point for such researches. The editor doubtless tries to be as impartial and comprehensive as possible; but its greatest value to one who wishes to answer a question similar to the present discussion, is that here he finds a list of names prepared by some one else, without any idea or bias in relation to the investigator's present problem. Thus the first, and one of the most important requirements is obtained, the subjective element is eliminated.

Some will not be willing to accept conclusions draw from a list which like this doubtless has certain flagrant omissions, and where he sees names that he considers should not have been included. If he will stop for a moment and think, he will see that the very objection he raises only argues in the other direction from what he supposes. If, for instance, I find a marked correlation between city birth and more or less notable subsequent achievement, drawn from an imperfect list, the correlation would be even higher were the list of names ideally perfect.

In "Who's Who in America" the birthplaces are given in nearly every instance, although they seldom enable one to differentiate between farm or village. This difficulty can, however, be overcome by making the question one of urban as against non-urban nativity.

The leaders of to-day are about fifty years old on the average, so we must go back a half century and picture American population as it was then distributed. According to the census of 1860, there were 5,072,256 persons living in cities of over 8,000 inhabitants, out of a total population of 31,443,321, or 16.1 per cent. This standard of 8,000 or more is the one arbitrarily taken by the census bureau as constituting a city, and is so used to illustrate the growth of urban populations. There were ninety-six such cities, and a list of them is given in the "Annual Cyclopedia" for 1861. It is easy then to see if these cities have done better or worse than might be expected in producing leading men. Under initial A in "Who's Who in America," we find 128 born in cities out of 433, or 29.6 per cent. as against the 16.1 per cent. expected.

Under initial B, we find 404 out of 1,477, or 27.5 per cent.

Under initial C, we find 362 out of 1,143, or 31.7 per cent.

Under initial D, we find 213 out of 676, or 31.6 per cent.

Under initial E, we find 97 out of 273, or 35.6 per cent.

For the sake of being on the safe side I have added all the unrecorded birthplaces to the suburban and rural, and yet the latter fail to produce their proper quota in every single group, and in fact every little group of fifty or a hundred taken at random alphabetically will show the same result.

It seems unnecessary to carry investigation further to establish the fact that the urban beats the non-urban by nearly two to one. The towns, villages and farms should have produced more than five times as many leaders as the cities. They have failed to produce more than about twice as many. Thus the entire non-urban which should have given rise to about 85 per cent. of the total has only produced about 70 per cent. As a great many persons are recorded as born in towns or villages, it is evident that the number from actual farms must be considerably under Mr. Spillman's 70 per cent., at least as far as the evidence drawn from this book is concerned. The inference is that since the cities beat the non-urban districts as a whole, the towns and villages would make a proportionately better showing than the farms, were the necessary data given.

Now, as to its bearing on the question of heredity. It is an easily verified fact that talent tends to be drawn by, and to locate itself in the great centers of human activity. If we turn to the geographical index in the back part of our same biographical reference volume, we find that the great cities, New York, Chicago, Boston, etc., show two or three times as many names as would be expected merely from their populations. I think no one will question the fact that there has been a migration and selection of the most able men, especially the ambitious and gifted young

men, towards the large cities and away from the small towns and farms. This change is in process at present, and must have been going on for some time. Thus there is every reason to suppose that by the year 1860 (if not very much earlier than this) there had already taken place a part at least of this same phenomenon. So that the distribution of talent was then somewhat as it is to-day, concentrated about the cities.[1] Now if mental traits are inherited, the cities must show a higher proportionate birth of talent than the country, and our observed facts are only what we might expect.

Of course it is impossible here to separate the question of environment, which may be more favorable in the city, as some contend, or less favorable, as others sometimes think, or be the slight and almost unmeasurable force which I, myself, shall be content to hold it, until some one has succeeded in measuring it.

Mental heredity, on the other hand, has been measured, and the results are in substantial agreement.[2]

It is not the purpose of the present communication to present these figures from "Who's Who" as a proof of heredity, but only to point out that there is nothing in the distribution of the birthplaces of leading Americans to conflict with the strongest belief in the force of inheritance, should one happen to have gained such a belief from other sources.

FREDERICK ADAMS WOODS

BROOKLINE, MASS.,
February 20, 1909

[1] Conf. J. McK. Cattell, "A Statistical Study of American Men of Science," III., SCIENCE, N. S., Vol. XXIV., No. 623, December 7, 1906. A. Odin, "Genèse des grands hommes," 2 vols., 1895.

[2] Conf. F. Galton, "Natural Inheritance," London, 1889. K. Pearson, "On the Inheritance of Mental and Moral Qualities in Man, and its Comparison with the Inheritance of Physical Characters," *Biometrica*, Vol. III., 1904. E. L. Thorndike, "Measurements of Twins," *Arch. of Philosophy, Psychology and Scientific Methods*, No. 1, September, 1905. F. A. Woods, "Mental and Moral Heredity in Royalty," *Popular Science Monthly*, August, 1902, to April, 1903. Same with additions and further measurements, New York, 1906.

SCIENTIFIC BOOKS

The Principles of Mechanics for Students of Physics and Engineering. By HENRY CREW, Professor of Physics in Northwestern University. 8vo, 295 pp. New York, Longmans, Green & Company. 1908.

This book represents a course which Professor Crew has given for several years at Northwestern University to students intending to specialize in physics and in engineering. The students have had a class and laboratory college course in general physics and more or less work in elementary calculus. Professor Crew states in the preface that his purpose is "to lead the student to clear dynamical views in the shortest possible time without sacrificing him upon the altar of logic, yet pursuing a route which he can afterwards follow with safety." The plan is to confine the treatment "to that part of mechanics which is common ground for the physicist and the engineer" (again quoting the preface). The general dynamical principles involving advanced calculus and analysis are accordingly not included. There are six chapters, one on kinematics, two on kinetics, one on friction, one on elasticity and a short chapter on fluid motion. As the title of the book indicates, the principles are emphasized rather than the applications. In making such a book, every one will, of course, have his own ideas as to topics to be included and those to be omitted. Professor Crew's book represents a course of the essentials, which has been selected after actual classroom experience. An excellent feature is the attention given to rotational dynamics, a part of mechanics on which many text-books are weak. The "illustrative problems" and "examples for practise" scattered through the book are very simple, avoiding involved analyses and calculations.

While the book is intended both for students of physics and of engineering, we believe it will appeal more strongly to the student of physics and this is not so much in its subject-matter as in its temper. For the general student, the purpose of the book is admirable—namely, to take the student in the

second year of his work in physics, immediately after the completion of a course in general physics, and to give him a thorough course in the principles of mechanics stated in the language of the calculus and vector analysis, but emphasizing the physics of the subject. The statement of physical facts and concepts in mathematical language is one of the difficult steps in a student's course; and Professor Crew has done well in giving us his introductory course in the mathematical side of physics.

The book is written in a style which is always clear and interesting. The forms of statement are fresh, and the author has drawn on a wide range of reading and experience for new and apt illustrations.

A. P. Carman

The Evolution of Forces. By Gustave LeBon. Pp. 388. New York, D. Appleton & Co. 1908.

In the controversy between Mr. Norman Campbell, of Trinity College, Cambridge, and Mr. F. Legge, of the Royal Institution, concerning Dr. LeBon's writings, Mr. Campbell said:

> I was a student of that author's works two years before his book appeared, and I believe that I have read every word that he has ever published on physical questions.[1]

On the basis of this thorough knowledge, Dr. Campbell places an extremely low estimate upon LeBon's work.

I have not read all of LeBon's writings by any means, but very certainly the present book on "The Evolution of Forces" is of little or no account, except in one respect only. If one wished to diagnose the ills of contemporary French science, one would find in LeBon exaggerated symptoms of a malady (nc of course affecting all French scientists) which has resulted from the tremendous scientific preeminence of the French during the early part of the nineteenth century. Let one consider the state of mind of a man who can express himself after the manner of the following quotations which are taken almost at random from LeBon's book:

> This happy confidence in the great dogmas of modern science remained unaltered until the quite recent date when unforeseen discoveries condemn scientific thought to suffer doubts from which it imagined itself forever free.
>
> There should, therefore, be no hesitation to examine closely the fundamental dogmas of science, for the sole reason that they are venerated and at first sight appear indestructible.
>
> After I had proved that the dissociation of atoms was a universal phenomenon and that matter is an immense reservoir of energy hitherto unsuspected in spite of its colossal grandeur, etc.

Speaking of a certain matter, LeBon says:

> As I expected, it was one of those classic errors repeated without verification to which repetition at length gives indisputable authority.

Speaking of another matter, he says:

> All *authors* have regarded it as having a preponderating influence.

There is one idea which, according to my experience, seems to be dominant in the minds of young students, namely, that the physical science which they study in the technical school or college is *in* the text-book and was created by a *literary effort* of an *author*. Dr. LeBon, apparently, has never got beyond this childish idea. The word author, as applied to a scientist, is misleading. Our scientific men in the United States do not combine sufficiently the ability to write with the ability to search and search again, so that, although it is mildly ridiculous to call many of them authors, it would be a distinct affront to speak of them narrowly as such.

W. S. Franklin

Contribution toward a Monograph of the Laboulbeniaceae. By Roland Thaxter. Part II. With 54 plates. Memoirs of the American Academy of Arts and Sciences, Vol. XII., No. VI. 4to, pp. 219–461. Cambridge, printed by Edward W. Wheeler. June, 1908.

Nineteen years ago Dr. Thaxter published his first paper on the Laboulbeniaceae,[1] and since that time has brought out many papers in which he has steadily added much to our knowledge of the species and genera and still

[1] The *Athenæum*, March 3, 1906.

[1] "On Some Species of North American Laboulbeniaceae," *Proc. Am. Acad. Arts and Sci.*, Vol. XXIV., February, 1890.

more of the structure and development of these curious entomogenous fungi. About twelve years ago he brought out "a stately quarto volume of two hundred and forty-two beautifully printed pages and twenty-six plates crowded with six hundred and seventy-two elegantly drawn figures," which the present writer reviewed in the *American Naturalist* (1897, p. 513). In this volume, which bore the same title as the one now before us, 28 genera and 158 species were recognized. And now in the second volume these numbers are increased to "more than fifty genera," and "about five hundred species and varieties." And we are told that since the completion of the plates "considerably more than one hundred additional new species have already accumulated," of which it is the author's expectation to publish figures and descriptions "with as little delay as possible."

The present publication adds to our knowledge of the structure of these plants in an instructive introductory chapter. In a brief and cautious discussion of their relationship Dr. Thaxter says:

> They are more surely Ascomycetes than many forms included in this group, and the writer sees no sufficient reason why they should not be placed in the Pyrenomycetes, as a group coordinate with Perisporiales, Hypocreales, etc.

In the systematic portion of the work the genera are arranged under two groups (orders?) viz., (I.) *Laboulbeniineae,* in which the antheridia are composed of "specially differentiated cells or groups of cells," and (II.) the *Ceratomycetineae,* in which the antheridia are composed of "more or less undifferentiated cells of the appendages or of their branches." In the first three are two families (?) viz., (1) Peyritschiellaceae (of 19 genera), with compound antheridia, and (2) Laboulbeniaceae (of 28 genera), with simple antheridia. The second order (?), which is composed of mostly aquatic plants, contains eight genera. The 44 plates are, if anything, better even than those in the previous volume, and enable one to get some idea of the structure of these very curious plants.

Dr. Thaxter asks his correspondents to communicate any additional material they may have, and it may be well to repeat here the suggestions he made in his earlier contribution in regard to the collection and preparation of Laboulbeniaceae for study (pp. 248–249).

> The collection of Laboulbeniaceae involves little more than the collection of a sufficient number of the proper hosts, although their presence on the latter is not always easy to ascertain in case of the smaller forms. In so far as concerns the collection of hosts my own experience . . . indicates that the most favorable localities in which to search for infested beetles is along the margins of small streams or of ponds. . . . Traps deposited in such situations, and made by raking together a heap of decaying grass, algae, etc., often yield large numbers of interesting specimens. Many forms may also be obtained by leaving bundles of hay or grass in cultivated ground for a few days and examining them over a sheet. Water beetles are in general best obtained by sweeping the margins of ponds or ditches with a dip-net. . . . Having obtained a number of hosts which are liable to be parasitized, it will be found that from about five to fifty per cent. will bear parasites. In order to obtain them for examination the host should be killed and impaled on a fine needle, care being taken that the surface of the insect remains perfectly clean and dry, and then examined over a dull white, and then over a black surface, with a hand lens magnifying about eight or ten diameters. . . . Every portion of the insect should be examined in different positions. . . .

Here is an opportunity for botanical collectors to exploit a new field near home, with the probability that new species or new hosts may be discovered. Any beetles on which these minute plants are found should be carefully packed, wet or dry, in clean cotton and sent to Dr. Thaxter, Cryptogamic Laboratory, Harvard University, Cambridge, Mass.

CHARLES E. BESSEY
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The Loose Leaf System of Laboratory Notes. By THEO. H. SCHEFFER, A.M. Philadelphia, P. Blakiston's Son & Company. 1908.

It fell to the lot of the present writer to review in SCIENCE of December 28, 1906, the first edition of this manual. The publishers have recently issued a "second edition, re-

vised." The revision comprises, as expressed by the author in its preface, "notes on three more types of animal life and is bound in a still more convenient form." Notwithstanding the closing statement of the author as to mode of binding, that of the former edition is continued without modification. On this point the reviewer had occasion to designate it as "the rather crude, *shoe-string* method." A more clumsy or inconvenient form of binding for such a manual could hardly be devised, and it is a pity the author's purpose of improvement might not have been realized.

Certain errors pointed out in the former review remain uncorrected in the present edition. C. W. H.

Ergebnisse und Fortschritte der Zoologie—herausgegeben von Dr. J. W. Spengel, Professor der Zoologie in Giessen. Bd. I., Heft 1, 1907; Heft 2, 1908. Jena, Gustav Fischer.

The undertaking of Professor Spengel and a corps of collaborators to present the results and progress of zoological investigation in a series of annual volumes will meet the hearty approval of zoologists everywhere. The general plan is to issue a series of parts as they are ready, so as to make up a volume each year of between 600 and 700 pages. The parts before us at the present time contain the following contributions: (1) "Die Chromosomen als angenommene Vererbungsträger," by Dr. Valentin Häcker, 136 pages; (2) "Die verschiedenen Formen der Insectenmetamorphose, und ihre Bedeutung im Vergleich zur Metamorphose anderer Arthropoden," by Dr. Richard Heymons, 53 pages; (3) "Die Scyphomedusen," by Professor Otto Maas, 50 pages; (4) "Die Amphineuren," by Dr. H. F. Nierstrasz, 68 pages; (5) "Die gegenwärtige Stand der Kenntnisse von den Copulationsorganen der Wirbeltiere, insbesondere der Amnioten," by Dr. Ulric Gerhard, 96 pages.

If the parts are a good promise of those to follow, it is obvious that the proposed series will have an exceedingly wide scope, so that the specialist in any particular field will not find his subject represented very often. But the object is rather to enable the student to obtain authoritative information of the state of investigation in lines other than his own, and this object will certainly be admirably accomplished by such reviews with their full lists of references. The writer would raise the question whether it would not be better to classify the separate contributions so as to give each volume an individual character? The *pros* and *cons* on this question are perhaps sufficiently obvious, and it is also obvious from the list of contributions to the first two parts that the editor will not take the responsibility of giving invidious precedence to any subject.

The publication has a field of its own which is not covered by the *Zoologische Anzeiger, Zoologisches Centralblatt,* the *Concilium Bibliographicum,* the *Jahresberichte,* or by Merkel und Bonnet's *Ergebnisse der Anatomie und Entwickelungsgeschichte.* The separate contributions to the first two parts are admirably concise, sufficiently complete and critically excellent. One must admire the enterprise of our German colleagues, who find time in the midst of unremitting investigation to sum up and present to the world these necessary records of progress, which contribute to the progress itself by the mere process of organization. So long as German scientists are willing to perform such necessary functions in so admirable a way, we of a newer country and culture are relieved of such duties and should be properly grateful. American science is no longer an undiscovered bourne in Germany; on the whole, the contributions of American zoologists to the subjects treated receive adequate recognition.

Frank R. Lillie
University of Chicago

SIR WILLIAM RAMSAY ON TRANSFORMATION OF THE ELEMENTS

In the course of his presidential address before the Chemical Society, London, on March 25, Sir William Ramsay said, as reported in the London *Times,* that his subject was the hypothesis that the genuine difference between elements was due to their gain or loss of electrons. The question was whether, to take a concrete example, an atom of sodium by

losing or gaining electrons remained an atom of sodium, or whether the loss or gain of electrons did not cause it to change into some other element or elements. Having stated some theoretical arguments in favor of the possibility of transformation, he went on to describe some experiments bearing on the question. He first mentioned the transformation of radium emanation into helium, which had been amply established. He next referred to his experiments on the action of emanation on solution of copper sulphate and nitrate. Four experiments were made, and with each exactly similar duplicate experiments were tried in which no emanation was employed. A larger residue was obtained in each case from the emanation solutions than from the duplicates, and while the residues from the emanation solutions showed a faint trace of lithium, those from the duplicates failed to give spectroscopic evidence of the presence of that element. The fact of the experiments having been carried out in duplicate rendered inapplicable the criticism of Professor Hartley that accidental contamination with lithium was probable. As regards the alleged repetition of the experiments by Mme. Curie and Mlle. Gleditsch, who, using platinum vessels, obtained no greater residue and no trace of lithium, there were two possible replies—either the conditions were varied, or conceivably a trace of lithium from the glass vessel employed (which, however, had been tested for lithium with negative result) was dissolved in presence of emanation and copper but escaped solution in absence of copper or of emanation. A research on the action of emanation on solution of silver nitrate contained in a silica bulb yielded negative results, but he had stumbled across a case of apparent transformation while working in a totally different direction. On December 20, 1905, 270 grams of purified thorium nitrate were dissolved in about 300 c.c. of water, and the flask in which the solution was contained was repeatedly evacuated by a mercury pump until no gas could be pumped off. The stopcock attached to it was then closed, arrangements being made so that if any leakage occurred it would be detected. After the flask had stood for 168 days the gas in it (5.750 c.c.) was pumped out and examined for helium with doubtful results. The flask was again closed, and on August 3, 1907, after 173 days, the gas in it was again examined. Again the presence of helium was questionable, but 1.08 c.c. of carbon dioxide was found. At the next examination, on March 30, 1908, there was distinct evidence of a helium spectrum, and the gas contained 1.209 c.c. of carbon dioxide. It was then thought possible that the carbon dioxide had been produced from the grease of the stopcock, and therefore a little mercury was introduced into the capillary tube leading to the stopcock so that the latter was protected from contact with the thorium solution. After 310 days the gas was again withdrawn. Instead of 3 c.c. or 4 c.c. no less than 180 c.c. were collected; it was almost pure nitrogen, but in all 0.622 c.c. of carbon dioxide was separated from it. These experiments, Sir William Ramsay said, rendered it at least probable that thorium engendered carbon dioxide, or, in other words, that carbon was one of its degradation products. Experiments futher indicated that the action of radium emanation on thorium nitrate solutions was also attended with the formation of carbon dioxide, and the same was the case with an acid solution of zirconium nitrate. An experiment with lead chlorate proved blank, but with bismuth perchlorate the formation of carbon dioxide appeared certain. In conclusion Sir William Ramsay, after mentioning that every precaution which could be thought of was taken to exclude foreign gas, said that while these were the facts no one was better aware than he how insufficient was the proof, and that many other experiments must be made before it could be confidently asserted that certain elements, when exposed to "concentrated energy," underwent degradation into carbon.

POISONOUS EMANATIONS FROM FERRO-SILICON

LAST December five Russian immigrants, the only steerage passengers on the steamer *Ashton* from Antwerp to Grimsby, were found dead on the arrival of the vessel at the latter port. Owing to bad weather the steerage ac-

commodations were tightly closed, while beneath was a cargo of ferro-silicon. The deaths were at first supposed to be from cholera, or possibly from ptomain poisoning, but these causes were subsequently excluded. The only noticeable symptoms found on post-mortem examination were connected with the lungs, which were in all cases strongly congested with dark venous blood. Cultures from the stomachs and intestines showed in several instances the presence of numerous vibrios, which so closely simulated those of cholera that they were with great difficulty distinguished from these. Suspicion was finally turned to the ferro-silicon as the cause of death and a series of experiments instituted which revealed the fact that under the influence of moisture poisonous gases are given off. Mice placed in jars over ferro-silicon soon showed symptoms of dulness and somnolency. When the ferro-silicon was moist, death preceded by disturbances of movement ensued in a few hours. Guinea-pigs under similar conditions succumbed in ten hours. The only abnormal feature on post-mortem examination was congestion of the lungs, such as is usually seen in cases of suffocation. Experiments were further instituted to determine what gases were responsible for the fatal results. Acetylene and hydrogen silicid were excluded and arsin found only in traces. Small quantities of phosphin (phosphoretted hydrogen) were found to be present, and this seems to be the principal poisonous constituent of the emanation. While little is known of the toxicology of phosphin, it is stated to be so poisonous that 0.02 per cent. of it in the air is fatal to small animals in half an hour. As ferro-silicon is formed by heating iron ore, quartz, coke and lime in an electric furnace, and as phosphorus is usually present in at least two of these constituents, phosphids, which evolve phosphin on treatment with water, would be present in ferro-silicon.

This investigation has served to throw light on several deaths which have been recorded in the past three years, which were undoubtedly due to ferro-silicon. In August, 1907, four persons died on the steamer *Olaf Wijk*, which was carrying ferro-silicon as part of its cargo. A short time before two children are recorded as dying on a Rhine steamer, having slept in a close cabin immediately over ferro-silicon, which composed a part of the cargo of the vessel. Four other cases of death on vessels carrying ferro-silicon are recorded, where the cause of death was not at the time suspected, but which are probably to be attributed to ferro-silicon.

As ferro-silicon is now used on a large scale in steel making, it is desirable that attention should be called to the fact that certain precautions should be taken in its transportation, especially that it shall be kept as dry as possible, and that it shall be well ventilated.

J. L. H.

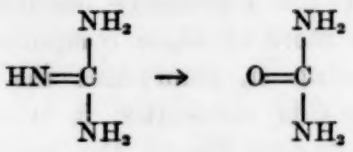
SPECIAL ARTICLES

THE PHYSIOLOGICAL SIGNIFICANCE OF CREATIN AND CREATININ[1]

Two fundamental observations have furnished the incentive to investigation and given the direction to hypotheses on the topic under discussion to-day. One of these was the discovery of *creatin* as a constant constituent of the muscular tissues of vertebrates; the other was the presence of *creatinin* in the urine of the higher animals. Creatin can be changed by the action of acids into creatinin, which in turn is supposed to form creatin in alkaline solutions. Since the chemist is able so readily to convert each of these compounds into the other in the laboratory, it was quite logical for the physiologist to assume some genetic relation between them in the living body. Creatin was looked upon as a product of protein metabolism in muscle, easily converted into its "anhydride" creatinin and thus eliminated in the urine. From this point of view two possible sources of urinary creatinin early suggested themselves, namely, an *exogenous* source in the muscle tissue (meat) consumed as food; and an *endogenous* origin,

[1] Papers read at the joint session of Section K—Physiology and Experimental Medicine—of the American Association for the Advancement of Science and the bacteriologists, biochemists and physiologists, Baltimore, December, 1908.

in the living muscles of the body itself. It was a further short step to associate muscular contraction with alterations in the creatin content of the contractile tissues; and to look for variations in creatinin output in relation to the muscular work done by the individual. In addition to this the creatin of the muscles has, because of its structural relationship, been discussed in the past as an important precursor of urea, on the assumption that the guanidin rest can be readily converted to urea in metabolism:



Ten years ago Dr. F. G. Hopkins wrote:

> The *variations* in the urinary creatinin generally follow very closely those of urea, but there can be no doubt that its quantity depends largely on the amount of creatin taken with the food.

At that time the story was as simple as it was brief. The creatin of the muscle was in some way derived from the proteins of the body; the creatinin of the urine was referable to the creatin ingested or furnished by the muscles of the body. Feeding experiments with meat and its products seemed to bear out this view and analogies lent further support.

From the outset the study of these problems was hampered by the lack of a suitable process for the estimation of these compounds. The Neubauer method, in which creatinin is isolated as a double salt with zinc chloride, was practically the only one available. Older testimony and more recent critical investigations leave no doubt that this method is utterly unreliable as a quantitative procedure for the estimation of creatinin. All of the earlier work based upon it must therefore be attended with a probability of error which has necessitated a revision of the entire subject. Here, as in so many other instances in scientific research, a good experimental method has opened up entirely new fields of observation; and to Professor Folin is due the credit for a satisfactory quantitative procedure for estimating creatin and creatinin based on Jaffé's color test with picric acid and an alkali. It has given the impetus to numerous investigations since its publication in 1904; in truth, this method, the simplicity of which makes it available in every clinic, has been responsible for a revolution in some of our ideas of metabolism. I propose to present some of these newer aspects of the physiology of creatin and creatinin, and to view them in the light of recent investigation; to inquire to what extent certain current hypotheses are justified. Bear in mind that a brief review within the limits of a symposium can neither be exhaustive nor do full justice to the newly accumulated mass of evidence; it is intended to be suggestive rather than critical—to propound problems rather than solve them.

Let us first consider the significance of creatin and creatinin in the muscle. The evidence now seems conclusive that creatinin is not present preformed in the muscular tissues (Grindley and Woods; Mellanby, '08; Mendel and Leavenworth). The fact that chemical manipulations of the extracts of muscle are quite likely to convert creatin into creatinin explains the constant occurrence of both of these compounds in commercial extracts of meat; and it warns against all conclusions regarding the physiological conversion of one compound into the other whenever appropriate conditions of analysis have not been rigorously maintained. When it is remembered that mere evaporation on a water-bath, under the acid reaction which arises post mortem, is sufficient to induce the conversion of creatin into creatinin, the liability of analytical error is emphasized. The difficulties are further increased by the fact that *quantitative* conversion of creatin into creatinin for analytical purposes is likewise attended with undeniable uncertainty (Folin, '06). These features are mentioned at the outset because they have served to complicate the experimental results to a degree where nothing short of experience seems to furnish adequate critique of the claims of investigators.

Creatin has been found in the muscles of all vertebrates which have been examined for it. From the phylogenetic point of view it is interesting, on the other hand, to note the absence of creatin from invertebrate muscle.

As we descend the scale it is still found in the lamprey, but missing in the arthropoda—the lobster and horseshoe crab, for example (Mellanby, '08; Lyman). This is only one of the chemical differences between vertebrate and invertebrate muscle and at once raises the question whether it is at all likely that creatin is functionally associated with contraction of muscle. Creatin apparently occurs in the non-striated variety of vertebrate muscle which is so frequently (and I believe without experimental justification) compared directly with the muscles of invertebrates (Saiki). Unfortunately, most of our information is still based upon the outcome of color tests rather than actual isolation experiments. Generally speaking the quantity of creatin seems to be larger in the muscles of warm-blooded animals, the hedgehog furnishing an unexplained exception in this series (Mellanby, '08).

Creatin is present in the embryonic tissues in mammals and in the developing chick, in which latter case it must be directly synthesized from the food-supply. Creatinin has not been found at any time (Mendel and Leavenworth; Mellanby, '08). In the chick the formation of creatin is apparently synchronous with, but independent of, the growth of the muscle. Mellanby has attempted to correlate the rapid increase in creatin during the later embryonic period with correspondingly rapid development of some organ, and naturally refers to the liver. He argues that since the cross-striated muscles of the invertebrates are identical with those of vertebrates —a contention which we are not inclined to admit as conclusive—and are creatin-free, muscle can not account for the phylogeny of creatin. Mellanby adds as a further biological speculation that since the "gland of the mid-gut" of invertebrates has no morphological or physiological connection with the liver of vertebrates, this newly introduced organ might account for the origin of creatin in vertebrate metabolism.

How constant is the creatin content of adult muscles; and is it altered during activity? In the light of the meager and conflicting data available to-day, a satisfactory answer can not be given to these questions. Yet they are of fundamental importance for any adequate discussion of the rôle of creatin. Mellanby's convincing experiments on isolated muscles showed that muscular work leaves creatin unaffected, as does the survival of muscle. The stability of muscle creatin is the keynote of his contentions. On the other hand, Graham-Brown and Cathcart reported an increase in the so-called total creatinin in stimulated frogs' legs when the organs were isolated, and a decrease when the circulation remained intact. Weber and Howell and Duke have observed that the vigorously beating isolated heart gives more of these compounds to the fluid perfusing it, than does the quiescent organ. In this connection it is of interest that, according to Uiano, the creatin of the muscle appears to be held in some non-diffusible form in the contractile tissue and is only released when the integrity of the muscle bundles is impaired. This observation may help to explain the unique property of muscle tissue to contain such conspicuous quantities of the compound.

We must bear in mind that all experiments such as those just reported are conducted under artificial conditions different from what pertains in normal muscular activity. The isolated or perfused muscles are working both without adequate repair of the contractile substance and under impoverished nutritive conditions. A disintegration of the tissues with possible liberation of creatin under such circumstances may be an incident in this *abnormal* situation rather than a customary expression of muscular contraction; just as we know that certain features of metabolism in starvation are the evidence of extraordinary katabolic changes rather than normal sequences. At any rate, we need to know more about the actual creatin content of muscle under a variety of both normal and unusual conditions, such as rest, activity, starvation and muscular disease, before the final word can be spoken.

The study of the metabolism of creatin and creatinin has lately received a new trend through the work of Gottlieb and his collaborators (Gottlieb, Stangassinger, Rothmann). An elaborate investigation of the behavior of

these compounds in autolysis led him to postulate that they can undergo a series of enzymatic transformations in the body, as follows: (1) Creatin can be formed in the autolysis of muscles and other organs. (2) Preformed or added creatin can be converted by enzymatic means into creatinin during autolysis. (3) In the progress of autolysis both of the compounds are destroyed by appropriate enzymes, creatase and creatinase. (4) The interaction of these processes affords a complicated curve for the creatin- and creatinin-content of autolyzing tissue extracts, since formation, conversion, and destruction may simultaneously go on. The behavior of creatin in the autolysis of different organs will vary according to the preponderance of one or the other of these different fermentative activities.

When we take into account the variations in the occurrence of these intracellular enzymes in the different tissues and note that the actual amount of creatin or creatinin found in an experiment at any moment represents the equilibrium point for a number of interdependent reactions the complexity of the situations becomes apparent. Truly a "bewildering array" of enzymatic processes, as Mellanby intimates in his severe critique of Gottlieb's work. Mellanby attributes the disappearance of creatin and creatinin to contaminating bacterial influences in these experiments; and he characterizes the conversion experiments as unconvincing because of the inappropriate analytical manipulations. Mellanby himself reports uniformly negative results on the behavior of creatin in autolysis. The repetition of these researches on the autolysis of tissues under more satisfactory conditions of control has, however, induced a number of investigators (van Hoogenhuyze and Verploegh, '08; Rothmann; Lefmann) to maintain the essential importance of endoenzymes in the metabolism of the compounds under discussion. Dakin has shown that arginase will not act upon creatin. The theory of the enzymatic transformation of creatin is comparable in many respects with accepted ideas regarding the metabolism of purins and other cellular products, and furnishes an attractive working hypothesis; it must, however, be admitted with reserve, if at all, until it rests upon a more substantial basis than the uncertain evidence of a color reaction.

This brings us to the facts in regard to the elimination of creatin and creatinin. The normal urine of healthy individuals contains no creatin whatever, or at most only traces. Folin's well-known observations demonstrated that the output of creatinin in an individual is practically constant despite very wide ranges of (creatinin-free) diet. This fact, now abundantly verified in many laboratories, led to the conclusion that the excreted endogenous creatinin is the expression of the true tissue katabolism, as distinguished from the exogenous protein katabolism consisting of a series of rapid hydrolytic cleavages resulting in the elimination of protein-nitrogen as urea. As might be expected, the output varies with the bulk of the metabolic tissues of the body, averaging about 15 to 20 milligrams per kilogram of body weight. The attempt to connect the excreted creatinin with tissue creatin has brought to light an apparent independence of these compounds in metabolism. Ingestion of creatinin results in increased creatinin elimination; but when creatin is fed to man or animals the creatinin content of the urine is scarcely altered, if at all (Folin, '06; Klercker; van Hoogenhuyze and Verploegh; Lefmann). Observations by Lefmann also uphold this for creatin introduced parenterally. It would appear, then, that creatin, when fed, is not converted to any extent into creatinin in the body. Furthermore, in distinction from creatinin, the creatin of the diet reappears at best only in small part as such in the urine. In the noteworthy feeding experiments of Folin the nitrogen of the creatin which disappeared was in some cases assumed not to be recovered in any form in the urine, especially where the diet was deficient in protein. Folin has advanced the tentative hypothesis that creatin may be one of those special products which serve to maintain the nitrogen equilibrium in the living tissues, but which do not easily take part in the urea-forming process; hence the muscle is found rich in creatin. When the organism is daily supplied with an abun-

dance of protein it may be preparing as much creatin as is needed for the maintenance of its normal supply. Creatin given with the food is consequently not retained by the muscles to the same extent as when the food contains an insufficient supply of protein.

Widely quoted as these experiments have been, they are scarcely conclusive on this point. Van Hoogenhuyze and Verploegh ('08) have lately maintained that the variations in the daily nitrogen output are large enough to exceed the quantities which Folin failed to recover when creatin was fed with a low diet. All feeding experiments are further complicated by the difficulty of ascertaining whether creatin is to any considerable extent destroyed by bacteria in the alimentary tract and thus escapes absorption as such. At present there is no way of telling what became of the creatin-N in the feeding experiments on record.

If, as we have learned, ingested creatin fails to increase appreciably the output of creatinin in the urine, must we not admit that the creatinin of the urine has an origin quite independent of the creatin of the muscle? "It would be most remarkable," writes Klercker, "if the endogenous creatin of the muscle were changed into creatinin in the body, whereas ingested creatin is not transformed in this way." It is, however, no more remarkable than the fact that ingested cystin may be completely oxidized in patients who are at the same time excreting the cystin which arises in their intermediary protein metabolism.

The recent investigations with the Folin method have shown that neither increased nor decreased muscular activity uncomplicated by other factors has any effect upon the excretion of creatinin (van Hoogenhuyze and Verploegh, '05; Shaffer, '08). This fact of itself can not speak against the origin of creatinin from creatin so long as it is not known what part creatin may play in the contraction of muscles. Shaffer has calculated a "creatinin-coefficient," representing the milligrams of excreted creatinin-N per kilogram of body weight, in a large number of individuals. This "coefficient" is regularly found low in individuals with lowered muscular efficiency and shows a parallelism with the muscular development and strength. He concludes that creatinin is not an index of the total endogenous protein katabolism, but is probably derived from, and an index of, some special process of the normal metabolism taking place largely, if not wholly, in the muscles. And upon the intensity of the process appears to depend the muscular efficiency of the individual. As a theory of metabolism this statement affords us little help; but as an expression of fact it elucidates a variety of interesting conditions. Thus the coefficient is found low in women, who as a rule are less developed muscularly than men; in infants with small bulk of muscular tissue; in the feeble aged; and in patients convalescent from wasting disease.

Creatin, not present in normal urines unless creatin is taken as food, is found in the urine during inanition and in certain pathological states. In starvation the creatinin output has been found to diminish gradually with the progress of the inanition. This is true likewise of another endogenous product, uric acid. The unique appearance of creatin under these circumstances must be borne in mind wherever this substance is found accompanying abnormal conditions attended by inadequate nutrition. In every such case it is reasonable to ascribe the source to the creatin of the muscles. Creatin may be excreted in acute fevers and various manifestations where there is a rapid loss of muscle proteins. Large outputs have been found in the urine of women during the first week post partum, when resolution of the uterus is taking place (Murlin; Shaffer). The fact that the creatinin elimination bears no appreciable relation to creatin in these conditions speaks further for the biological independence of the compounds.

There are numerous data already on record in attempts to connect the liver and other organs with the phases of metabolism which we are considering. It is almost too early to interpret these adequately because of the complexity of factors involved (Mellanby, '07; Spriggs, '07; van Hoogenhuyze and Verploegh, '08). In many instances, especially in the cases of hepatic disease, under-nutrition is an ever-present complication. Other cases, such as the muscular dystrophies with lowered cre-

atinin output, have a more immediate interest. Clinical investigators seem to forget that in these experiments of nature one rarely deals with simple conditions where a single organ, such as liver or muscle, is independently involved.

To attempt to formulate a theory of creatin and creatinin metabolism at this time would, in my judgment, be premature. It may, however, help us to crystallize the discussion by outlining some salient points of view. I think it will be agreed that the muscle plays a comparatively small part in the formation of creatinin. Let us assume for the moment that creatin represents a metabolism product originating in various organs, perhaps notably in the liver. It is transported about and especially deposited in the muscle in some non-diffusible combination. Most of it will be destroyed in ways that may be facilitated by enzymes. Here again it appears likely that the liver plays a prominent rôle. A part may be changed to creatinin, which may in turn be either destroyed or excreted. For this part of our hypothesis the evidence is most uncertain. Creatinin behaves as a waste product; it is decomposed with greater difficulty than is creatin, and it is eliminated more readily. But whether it represents a real end product, or like uric acid is an intermediary product, the output of which we associate with a balance between productive and destructive processes, can not yet be determined. At any rate, unchanged creatinin is promptly excreted and is nowhere to be found in detectable quantities in the organism. When the functional activities of the body are depressed or stimulated corresponding variations in creatin production and destruction may go on (van Hoogenhuyze and Verploegh, '08). So long as effective katabolic powers are maintained, the variations in creatinin output will be slight at most and in correspondence with the physiological state. Any excess of creatinin will represent only a fraction of the undestroyed increase in creatin. From this point of view the muscles would furnish creatin only as physiologically active organs and not as an incident of their contraction. The energy for contraction comes from quite different sources. When, however, the tissues are drawn upon for supplies, as in hunger or cachexia, creatin is liberated by the disintegrating muscle; and owing to the lowered effectiveness of the katabolic organ, let us say the liver, the creatin now escapes destruction and is eliminated as such. In other words, in normal metabolism creatin is continually produced and destroyed, or converted to creatinin which is speedily eliminated. In starvation preformed creatin is liberated; and neglecting to experience the customary destruction, it escapes unchanged. Here creatin is a product both of metabolism and of tissue resolution.

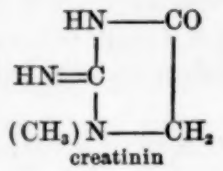
It is an easy task to offer objections to the outline just presented. A primary source of difficulty lies in the failure of most investigators to demonstrate that creatin, introduced into the circulation, in any way affects the output of creatinin. I have already spoken of this fact. Perhaps we have not yet succeeded in imitating the conditions of equilibrium which pertain in normal metabolism. Mellanby has protested against the conventional interpretation and lays primary emphasis upon creatinin, which he regards as being continually formed in the liver from substances brought to it. In the developing muscle this is changed to creatin and stored as such until a saturation point is reached, whereupon creatinin is continuously excreted. Mellanby urges that from a chemical point of view it is easier to assume the preliminary production of a cyclic structure like creatinin and its subsequent conversion to creatin, than the reverse process. Creatin is neutral and innocuous, and not likely to be changed to the strongly basic creatinin. The argument is teleological and not convincing; and to the liver are ascribed functions for which there is little evidence under either theory.

More profitable than this hypothetical discussion will be a consideration of some of the investigations which are immediately demanded. At the outset we need to know more definitely about the possible distribution of creatin in the tissues and blood; and above all, whether the creatin content of the muscle is normally a constant, as some maintain, or subjected to variations incident to activity,

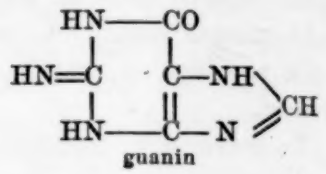
growth or atrophic changes. In view of the growing mass of data on the fate of ingested creatin and creatinin there is an unfortunate paucity of information regarding the changes which they experience after parenteral introduction into the body, where the uncertainties of change or loss in the alimentary tract are obviated and exact dosage becomes a possibility. The tendency to relegate important metabolic functions to the liver points to the desirability of studies on the fate of the nitrogenous katabolites in animals in which the hepatic functions have been excluded. In the only reference which I have found on this point, creatin was reported in noteworthy amounts in the urine of a dog after the Eck fistula operation and further extirpation of the liver (Salaskin and Zaleski).

The questions raised by the discussions regarding the intervention of enzymatic processes are timely and preeminently significant. Here, however, the limitations of the present colorimetric method are most likely to impede satisfactory progress and they invite the consideration of the analyst. The nature of the relation between inanition and excretion of creatin must be analyzed into its possibilities. Are we dealing with a general depression of katabolic organs in inanition? Or is the absence of metabolizable energy-yielding products in the tissues the sole factor? These questions are being investigated at present in our own laboratory. The behavior of the creatin bodies in the presence of microorganisms of the alimentary tract likewise deserves study, especially in view of the constant finding of methylguanidin among the products of bacterial action on creatin (Nawiasky), and of methylguanidin and dimethylguanidin in the urine (Achelis).

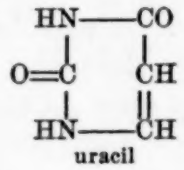
One can not conclude this topic without reference to the possible nitrogenous precursors of creatin and creatinin in the body. Speculation has been rife and claims have been numerous. That protein feeding does not *per se* increase the output in the urine has been conclusively demonstrated. Experiments with nucleic acid compounds (with thymus glands) which yield purin and pyrimidin derivatives structurally similar to creatinin, have had a negative outcome (Burian; Jaffé; Dorner; Lefmann).



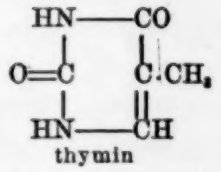
creatinin



guanin

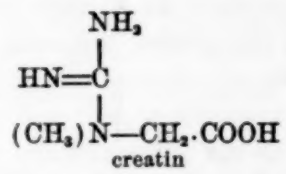


uracil

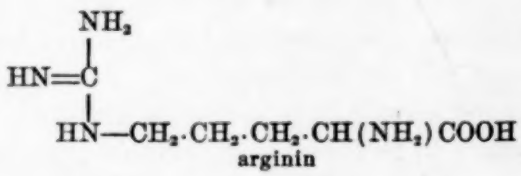


thymin

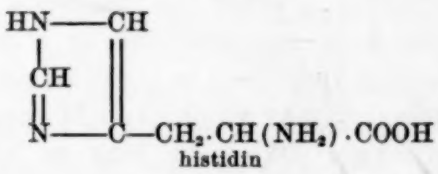
The experience with methylguanidin and with glycocyamin (guanidin acetic acid) is negative or uncertain at best (Jaffé; Dorner; Achelis). W. Koch's hypothesis relating creatinin to the metabolic change of methyl groups in the body and connecting it with the metabolism of the phosphatids (lecithin and kephalin) remains an interesting but unverified assumption. The guanidin derivate arginin stands structurally in close relation to creatin; while histidin, with its imidazole structure presents little more than analogy.



creatin



arginin



histidin

With neither of these compounds have experimental relations to creatin and creatinin been established. The nature of their synthesis still remains within the realms of surmise, inviting the organic chemist, as has so often been the case in biology, to supplement the efforts of the physiologist.

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Yale University

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION D—MECHANICAL SCIENCE AND ENGINEERING

THE meetings of the section were held in the lecture rooms on the third floor of the chemical laboratory of the Johns Hopkins University. In the absence of President G. F. Swain, the vice-president of Section D, Professor Mansfield Merriman, was chosen to preside over the meetings of the section.

Professor C. A. Waldo was elected a member of the council.

Professor C. M. Woodward was elected a member of the sectional committee.

Professor Mansfield Merriman was elected a member of the general committee.

Mr. J. F. Hayford was elected vice-president for the ensuing year.

The program consisted of eight papers read by their authors, five papers read by the secretary in the absence of the authors and three papers read by title in the absence of the authors.

The vice-presidential address which was to have been given by Professor O. H. Landreth on the subject "Governmental Control of Public Waters" was omitted on account of the unavoidable and unexpected absence of Professor Landreth. The address will be published in full in a later number of SCIENCE.

Mr. B. R. Green, of the Library of Congress, Washington, D. C., in speaking on the subject "Library Book Stacks without Daylight," said in substance that daylight is extremely variable, uncertain and expensive to secure in the construction of a library book stack. At best it is injurious to the books. At least it is almost useless. Stacks must be used much at night, requiring artificial illumination. The modern electric light solves the difficulty, and, at small expense, enables the stack to be built and enclosed anywhere and be perfectly illuminated at any and every desired point within it at any time of day or night. During the discussion the writer pointed out the great economy of space which can be effected where dependence is not placed upon daylight, and cited dimensions and other data from additions to the stack space recently made in the Library of Congress.

The Testing of Transformer Steel" was presented by Mr. M. G. Lloyd, of the Bureau of Standards, Washington, D. C. In his paper he described a new apparatus for determining the constants of transformer steel, which apparatus is a modification of the Epstein apparatus, and presented tabulated and charted results obtained with the new apparatus from ordinary steels and from the special alloy steels now being used for transformer cores.

Mr. J. H. Hayford in demonstrating that "It is not Necessary to Place Geodetic Arcs in Various Latitudes" said, in effect, that the idea seems to prevail that, in order to determine the flattening of the earth from geodetic measurements it is necessary to make the measurements in various latitudes. The basis for this idea is that the flattening must be determined by measuring radii of curvature of the spheroid which differ considerably from each other, and that arcs of the meridian in high latitudes, near the poles, have relatively long radii of curvature and those near the equator relatively short radii. But the attention should not be confined to arcs of the meridian. Since the introduction of the telegraphic method of determining longitudes, arcs of the parallel are as important as arcs of the meridian.

The flattening may be determined by measuring the difference of the radii of curvature of two arcs in any latitude, one an arc of the meridian and the other an arc of the parallel. The measurement of the latter determines the radius of curvature of the spheroid in the prime vertical plane, which, in all parts of the United States, is much longer than the radius of curvature in the meridian. The prime vertical radius is longer in latitude 49° than the meridian radius in latitude 67°. By utilizing measurements of both arcs of meridians and arcs of parallels made within the United States as great a difference of radii can be secured as from arcs of the meridian alone, scattered from latitude 26° in southern Florida to latitude 67° in northern Alaska, and three fourths as great a difference as can be secured from arcs of the meridian scattered from the equator to the poles.

These and other considerations indicate that progress is to be made in determining the flattening of the earth from geodetic measures, by securing large continuous areas of triangulation well supplied with astronomic observations, these areas to be in the most convenient localities, rather than by securing measurements of arcs of the meridian scattered through a large range in latitude.

Mr. J. Burkitt Webb, of Hoboken, N. J., discussed the subject of "House Warming." The following is an abstract of his remarks:

Direct and indirect heating, or heating by radiation and convection were compared and the former held most natural and preferable; the poisonous nature of the air of the ordinary hot-air furnace was exposed and compared with the wholesome effect of a fireplace, and hot water or steam heat discussed as a mean between the two.

The relative advantages of steam and hot water and the methods of installing these systems; the position, shape and color of radiators; the methods of generating and distributing the steam or hot water, and the method of regulation were discussed.

Professor C. N. Ricker, of Urbana, Ill., in a paper entitled "A Study of Plain Metal Base and

Bearing Plates," which was illustrated by twenty-five or thirty lantern slides, presented a summary of a bulletin soon to be issued by the Engineering Experiment Station of the University of Illinois.

The author deduced the proper theory of resistance of base plates, formulas for the safe thickness of plates of rectangular and tapered cross-sections of cast iron, and recommended the substitution and use of the straight line formula in place of the theoretical formula of very tedious application, the construction and use of a series of graphical tables for rapidly and accurately determining the dimensions and thickness of base plates employed in practical construction.

Professor A. H. Blanchard, Providence, R. I., who is assistant engineer for the State Board of Public Roads of Rhode Island, presented "An Analysis of Highway Traffic in Rhode Island."

The conclusions drawn by the writer for the roads examined are:

1. The amount of motor-car traffic which will cause disintegration is much less than is generally supposed.

2. In the case of two roads subjected to practically the same amount of motor-car traffic, the rate of disintegration will depend upon the location of the road, other conditions being equal.

3. The rate of disintegration of an ordinary macadam surface will vary almost directly as the percentage of motor-car traffic.

4. The popular belief that trap rock is the ideal road material for the surface of all macadam roads independent of the nature of the traffic to which they are subjected is a fallacy. In the case of roads subjected to horse-drawn vehicle traffic consisting of pleasure and light commercial traffic, or subjected to motor-car traffic, either exclusively or in combination with light horse-drawn vehicle traffic, the trap rock surface is exceedingly expensive to maintain. This is due to the fact that very little dust is furnished by abrasion on account of the hardness of the broken stone and hence, the binder being absent, the surface ravels under horse-drawn vehicle traffic or is disintegrated by motor-car traffic.

5. Bituminous macadam roads require a sealed surface when the highway traffic consists of a combination of heavy motor-car traffic and heavy horse-drawn vehicle traffic, while the sealed surface is not a requisite when the road is subjected to only heavy motor-car traffic. The sealed surface is considered necessary for the first class as insurance against the disintegration of the surface due to the liability of the loosening of the exposed stone by blows from the hoofs of horses and the rapid enlargement of any break in the surface by motor-car traffic.

"Recent Progress in Aeronautics," by Major G. A. Squier, U.S.A., has already appeared in SCIENCE (February 19, 1909). The lecture was very completely illustrated with lantern slides and set forth the present state of the art in a pleasing and impressive manner.

In this connection, it should be noted that the association has decided to foster this growing branch of applied science. The council will refer all papers on engineering and aeronautics to Section D, whose officers will cooperate with their authors for adequate presentation and publication.

In the paper on "State Engineering Experiment Stations," by Professor G. W. Bissell, East Lansing, Mich., the writer reviewed and compared some of the provisions of the Hale and the McKinley experiment station bills, of which the latter is now before Congress and presented the principal arguments for such a measure.

The following papers were read by the secretary in the absence of the authors:

New Methods of Back-water Computations: Professor B. F. GROAT, Minneapolis, Minn.

Variation of Pressure on the Side of a Track Spike: Professor H. S. JACOBY, Ithaca, N. Y.

Note on Specially Designed Corliss Engine for Experimental Work: Professor A. M. GREENE, Jr., Troy, N. Y.

The Specific Speed of Hydraulic Turbines: Professor L. P. MOODY, Troy, N. Y.

On the "Degree" of Railroad Curves: Professor W. G. RAYMOND, Iowa City, Iowa.

The following papers were read by title:

A Problem for State Engineering Colleges: Professor A. E. HAYNES, Minneapolis, Minn.

Temperature Stresses in Reinforced Concrete Chimneys: Professor E. R. MAURER, Madison, Wis.

A New Type of Reinforced Building Construction: Professor J. J. FLATHER, Minneapolis, Minn.

All papers were interesting and valuable and evidenced care in their preparation. The program should have been published in SCIENCE in advance. The secretary will see that this is done for the next meeting.

G. W. BISSELL,
Secretary

SOCIETIES AND ACADEMIES

THE NEBRASKA ACADEMY OF SCIENCES

THE nineteenth annual meeting of the Nebraska Academy of Sciences was held in Lincoln, Feb-

ruary 12 and 13. A larger number than usual of members out in the state were present. President A. A. Tyler delivered the president's address, on "Evidences of Evolution from the Development of Leaves."

The following papers were read before the academy:

"The Brown Chert of the Republican Valley," by E. E. Blackman.

"The Manufacture of Hog Cholera Vaccine," by A. T. Peters.

"The Season of 1908 in the Sioux County Bone Beds" (illustrated), by E. H. Barbour.

"Geometry as Pure Mathematics," by E. W. Davis.

"Paint and the Protection of Lumber," by J. Mortenson.

"Modeling Plant Structures in Paraffin," by R. J. Pool.

"A Preliminary Study in the Ethnobotany of Nebraska," by M. R. Gilmore.

"Notes on Western Indian Language," by A. E. Sheldon.

"The Scientific and Practical Value of Making Nebraska a Tuberculosis-free State," by H. W. Orr.

"A Plan for Completing the State Flora," by C. E. Bessey.

"Some Features of the Flora of Grand Island, Nebraska," by C. J. Elmore.

"The Problem of Defective Sight," by H. B. Duncanson.

"Comparison of Parasitic Fauna in Atlantic and Pacific Salmon," by H. B. Ward.

"Are Species Realities or Concepts Only?" by J. H. Powers.

"Legislative Restrictions to Animal Experimentation," by A. E. Guenther.

"The Importance of a Sanitary Milk Supply," by H. H. Waite.

"Is the Number of Chromosomes a Test in the Alternation of Generations in Plants?" by R. J. Pool.

"Notes on the Missouri Valley Loess," by S. W. Stookey.

"Measurements of Evaporation in Nebraska," by G. A. Loveland.

The session on Saturday afternoon was given over to a symposium on the "Economic Resources of Nebraska" with the following subjects and leaders:

"Trees"—Professor F. J. Phillips.

"Birds"—Professor R. H. Wolcott.

"Insects"—Professor L. Brunner.

"Forage and Fruits"—Professor C. E. Bessey.

"Minerals"—Professor G. E. Condra.

"Fish"—Professor H. B. Ward.

The academy accepted the invitation of the Nebraska Chapter of the Sigma Xi to hear the address of Professor A. G. Webster, of Clark University, on "The Creed of a Scientist," and adjourned its regular meeting on Friday evening in order to join with the botanical seminar in a Darwin anniversary meeting with the following program:

"Pre-Darwinian Evolution," by Mr. Pool.

"The Life of Darwin," by Dr. Walker.

"Darwin as a Zoologist," by Professor Ward.

"Darwin and the Geological Record," by Professor Barbour.

"Darwin's Contributions to Botany," by Professor Bessey.

"Darwin's Contributions to Plant Physiology," by Professor Wilcox.

The following were elected officers of the academy for the coming year:

President—Professor G. E. Condra, Lincoln.

Vice-president—Professor A. T. Bell, University Place.

Secretary—Professor F. D. Barker, Lincoln.

Treasurer—Professor R. J. Pool, Lincoln.

F. D. Barker,
Secretary

The Academy of Science of St. Louis

On Monday evening, February 15, 1909, the regular meeting of the St. Louis Academy of Science was held at the Academy Building, 3817 Olive Street. The following program had been arranged by the committee to commemorate the centenary of the birth of Charles Darwin (February 12, 1809):

"Darwin as a Naturalist," Professor S. M. Coulter.

"Darwin's Influence upon Geology," Professor W. E. McCourt.

"The Natural Selection Theory and its Later-Day Critics," Professor J. F. Abbott.

"Some Aspects of Darwin's Influence upon Modern Thought," Professor A. O. Lovejoy. (Read by Dr. Joseph Grindon.)

At the conclusion of the special program, Professor Nipher presented to the academy some changes in the manner of his experiments, and some of the additional results that he has obtained in his studies of "Momentum Effects in Electric Discharge"—reports of which have from time to time appeared in Science.

He reported that he had modified the arrangement of the wire forming the angle, in his study

of momentum effects in electrical discharge. The angle is now formed as follows: A vertical wire leads downward to the plate-holder. Its lower end terminates in a pin, the head of which is soldered to the end of the wire, and the point of the pin is just above the cover of the plate-holder. Its distance from the cover can be varied by vertical adjustment. The horizontal wire forming one side of the angle has one end soldered to the vertical wire, thus making a right angle. The distance from this junction to the pin may be varied. Satisfactory operation is ob-obtained when the junction is midway between the head and the point of the pin. In this way a right angle is formed with a discharge point below the vertical wire, and in line with it. Such angle-wires may be coupled with each other by joining either their horizontal or their vertical wires. The results are the same as those announced heretofore.[1] But the results are more easily obtained with this arrangement than with the one previously described.

Professor Nipher also finds that the shadow pictures obtained depend upon the material of the plate-holder. With a cover of paper or thin hard rubber, the presence of electrons is shown by branching discharge lines from the images on the film. Refraction effects are also clearly shown. When the cover is of glass or mica, with black paper, the images are like those formed by X-rays, and no refraction is shown.[2] By using a machine of large capacity and by arming a metal plate with many points directed toward a sheet of glass, shadow pictures of larger objects may be obtained.

W. E. McCOURT,
Recording Secretary

THE TORREY BOTANICAL CLUB

THE first meeting of the club for 1909 was held at the American Museum of Natural History on January 12, President Rusby in the chair.

This being the annual meeting, reports were presented by the treasurer, editor, chairman of the field committee and secretary. These were read, accepted and placed on file.

The following officers were elected for the year 1909:

President—Henry Hurd Rusby.

Vice-presidents—Edward Sandford Burgess and John Hendley Barnhart.

Secretary—Percy Wilson.

Treasurer—William Mansfield.

Editor—Marshall Avery Howe.

Associate Editors—John Hendley Barnhart, Jean Broadhurst, Philip Dowell, Alexander W. Evans, Tracy Elliot Hazen, William Alphonso Murrill, Charles Louis Pollard and Herbert Maule Richards.

THE meeting of the club was held at the Museum of the New York Botanical Garden on January 28, President Rusby in the chair.

The scientific program consisted of two papers, of which the following abstracts were prepared by the authors:

Studies in the Embryology of the Mistletoe, Dendropemon: Miss MARY M. BRACKETT.

This study was made from two species of Loranthaceæ—*Dendropemon caribæus*, gathered by Professor F. E. Lloyd from lime-trees in Dominica, and *Dendropemon parvifolius* collected by the writer from the bitter-broom, *Baccharis*, at Cinchona, in the Blue Mountains of Jamaica.

The flowers of *Dendropemon* are perfect, regular and symmetrical. The buds form in clusters of three in the axils of the leaves, and are protected by bracts. The corolla consists of six petals, which, in *D. parvifolius*, are of a reddish color on the outside, and a delicate pink within. There are six stamens borne upon an inferior ovary, the three fertile stamens alternating with three sterile stamens. The flower has one style and one stigma. At the top of the ovary is the cup-shaped calyculus.

At the time that the corolla and stamens appear as rounded knobs, two carpellary leaves meet over a central placenta, forming a cavity. The carpellary and placental tissues gradually unite, filling the cavity. Growth in the length of the pistil begins to be rapid, and the stamens develop. During this time cell-division is going on in the region of the nucellus. There is, however, nothing to mark the development of an ovule as a distinct organ, nor is there any indication of integument. In the center of the ovary the cells increase in number and size and contain large nuclei. They elongate parallel to the main axis, become irregular, and constitute the archesporial tissue. Their growth is accompanied by periclinal division in the adjacent cells. Several large archesporial cells form megaspores; the neighboring cells become disorganized and gradually disintegrate. Apparently only one of the megaspores becomes an embryo-sac.

[1] SCIENCE, July 14, 1908, and December 4, 1908.
[2] SCIENCE, February 5, 1909.

The embryo-sac was not made out in these species; but a long slit was observed reaching from the center of the ovary into the tissues of the style, which, it seemed, had been occupied by the embryo-sac. Of this Hofmeister says ("Neue Beitrage zur Kenntniss der Embryobildung der Phanerogamen," 539. 1859): "The growth in length of the embryo-sac is not ended with its formation. The sac makes its way through entangled cells of the closed style to a quarter of its length upwards."

Young stages of the proembryo were observed composed of four, and then of six cells in two parallel rows, with the long suspensor, of three greatly elongated cells, reaching into the tissues of the style for nearly half its length.

The embryo occupies a vertical position in the center of the berry, and from its position in the surrounding tissue, suggests all the characters of an orthotropous ovule. As the embryo develops, it is surrounded with endosperm. A change in the nature of the tissue below the embryo suggests a series of conducting cells between the embryo and the starch-filled cells in the lower part of the ovary. The cotyledons become green, and the suspensor gradually disappears, except for a few capping cells at the anterior end of the embryo, which now occupies the ovarial cavity for almost its entire length.

The points of particular interest are: the rapid disintegration of the cells of the gynœcium before and after fixation; the lack of an ovule as a distinct organ; the lack of integument; and the green color of the embryo as it lies in the berry.

Botanical Observations in Iceland and Spitzbergen: Miss Julia T. Emerson.

In July, 1908, the writer was so fortunate as to take a three-weeks' trip, touching at the following places: Kirkwall, in the Orkney Islands; Thorshavn, the chief town of the Faroes; the city of Reykjavik and village of Akreyri, in Iceland; Advent Bay and Bell Sound, in the Island of Spitzbergen; and then south to the North Cape of Norway and many places of interest on that coast.

Although all the points visited were on the coast or within reach of salt water, the flora changed according to the latitude, just as it does when one climbs a mountain, and as we went north we left behind the summer or spring vegetation which we found in Kirkwall, passed a treeless growth in Iceland, and at Spitzbergen came to an alpine flora with representatives found in the United States only on mountain summits or in the high Rockies. For instance, at Thorshavn buttercups, marigolds, forget-me-nots, daisies and other spring flowers were in bloom, and there were potatoes and gooseberries in the gardens. Our first sight of Iceland had been of great snow-fields, and we were astonished, therefore, to find any familiar plants on land. In the town were some of the plants mentioned above and two little specimens of trees, a sycamore maple and a mountain ash, very stunted, and the vegetables would not have grown without protection of the houses and good soil; on the great stony stretches which surround Reykjavik a little pink thyme, *Statice maritima*, *Silene maritima* and *S. acaulis*, *Polygonum viviparum*, *Alchemilla alpina*, several species of *Galium* and *Tofieldia palustris* were more or less abundant, and at Akreyri there was quite a luxuriant vegetation near a little waterfall outside of the settlement; pretty *Dryas octopetala*, *Eriophorum angustifolium* and *E. vaginatum*, *Parnassia palustris*, *Viola tricolor*, *Pinguicula vulgaris* and some of our ordinary weeds, also a number of mosses, especially *Grimmias*. At Spitzbergen the stones, where not covered by snow, were gay with the Iceland poppy, *Saxifraga oppositifolia*, pink or white and with a delicate odor, beautiful *Pedicularis lanata*, the pink of the flowers showing through a veil of gray hairs, *Potentilla emarginata* and *Cassiope tetragona*, making a sort of turf or bog close to the melting snow. Here we had twenty-four hours of sunshine, and the scenery was of strong contrasts, wet black or gray rocks, dazzling glaciers and dancing blue waters, where numberless birds fearlessly rested or floated about.

The contrast between these arctic conditions and the rich growth of grass, sweet yellow violets, pink campions and geraniums, etc., which we found growing in the flank of the North Cape of Norway, was very marked, but on the flat top of the cape there was only a scanty number of hardy stone-crops and other low things which could find protection between the stones from the fierce winds. The first trees seen on the southward part of the journey were birches, and they were at Lyngenfjord, still north of the arctic circle. In climbing the mountain at Digermullen we noticed the following plants, *Calluna vulgaris*, whose common name of "lyng" is said to have suggested the name of the fjord, *Cornus succica*, violets, *Trientalis europæa*, *Vaccinium* and *Andromeda polifolia*.

The two days spent at Merok and Gudvangen amidst their stupendous cliffs and beautiful fjords were a fitting climax to an inspiring and wonderful cruise.

Dr. Britton showed a photograph of a new and interesting cycad collected by Dr. MacDougal and Dr. Rose in Tomellin Cañon, Mexico, in 1906. The plant was sent to the New York Botanical Garden and installed in the propagating houses, where it remained for two years before showing any signs of growth. This appears to be a new species of *Dioon*.

Dr. Murrill exhibited a number of tropical fruits obtained on his recent trip to Jamaica.

THE club met at the American Museum of Natural History on February 9, at 8:15 P.M., and was called to order by President Rusby.

The announced paper of the evening on "The Rubber Forests of Mexico" was then presented by Dr. H. H. Rusby. The lecture was illustrated by lantern-slides made from protographs, many of which were obtained by the speaker while in the field. This paper has been printed in full in the January number of the *Journal of the New York Botanical Garden*, and an abstract accompanied by illustrations will appear at an early date in *Torreya*.

PERCY WILSON,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

THE ninetieth regular meeting of the section was held at the Twentieth Century Club, Boston, on February 19, Dr. Arthur L. Day, director of the Carnegie Geophysical Laboratory, of Washington, D. C., addressed the section on "Some Recent Work in Geophysics." After pointing out the necessity of applying the principles of physical chemistry to the solution of many geological problems, the speaker described the electrical furnaces used in his laboratory for maintaining temperatures of about 1,500° C. He stated that the transition points for a number of one-component and two-component systems of minerals had been determined at this high temperature and that work was now in progress on a three-component system.

Professor Henry P. Talbot, of the Massachusetts Institute of Technology, presented a paper upon "Present Conceptions of the Action of the Common Indicators used in Acidimetry, and Some of their Applications." The recent advances in the knowledge of the reactions which indicators themselves undergo in changing from acid to alkaline solutions was fully reviewed and the advantages to be derived by the proper choice of indicators was clearly illustrated by experiments.

KENNETH L. MARK,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 454th meeting was held February 6, 1909, with President Palmer in the chair.

Dr. M. W. Lyon, Jr., exhibited skins and skulls of the oriental genus *Gymnura* and of the American opossum, *Didelphis*, and pointed out the close general superficial resemblances in external and cranial characteristics of these two groups of mammals from such widely separated portions of the world and members of different superorders, the Monodelphia and the Didelphia.

The chair noted the capture near Washington, on September 1, 1908, of a specimen of the little black rail, by Mr. H. M. Darling, on the eastern branch of the Potomac. For the locality this is the third actual specimen and fourth record of this the smallest of the game birds, the first record for the District of Columbia being in 1861. Though its range is from Massachusetts to the West Indies and Guatemala, the bird is seldom seen.

Dr. O. F. Cook, in a brief statement on "Mitapsis and Amitapsis," called attention to the possible importance of the recent investigations of Dr. Reginald R. Gates, of Chicago University, in the cytology of *Œnothera*. The suggestion was made that the lack of any evidence of fusion of chromatin threads at synapsis may be of more significance than the subsequent differences in the number or distribution of the chromosomes. The name *amitapsis* was proposed for the newly discovered condition in which no fusion of chromatin takes place, to contrast with *mitapsis*, the name given by Cook and Swingle to the process of chromatin fusion, considered as the final stage of the process of conjugation. Mitapsis has no necessary connection with synapsis, which is the name of the closely coiled condition of the chromatin skein. Gates finds synapsis in *Œnothera*, but no indication of mitapsis; the extremely delicate threads visible before synapsis are simple. A longitudinal splitting begins after synapsis, but is not carried out, and the new chromosomes are formed in a single chain.

If amitapsis should prove to be associated with self-fertilization it would help to explain why self-fertilized plants produce highly uniform progeny, as in vegetative propagation, whereas the progeny of normally cross-fertilized plants have notable individual diversity. Germ-cells arising through amitapsis could be viewed as vegetative products, rather than as fully sexual products of conjugation. It is easy to understand that the union of amitaptic germ-cells might merely reproduce the parental characters. Thus amitapsis may account for the uniformity of self-fertilized types, as well as for their liability to mutative derangements of characters.

The regular program consisted of the following communications:

The Blue Foxes of the Pribilof Islands: James Judge.

The blue foxes of the Pribilof Islands are presumed to have come from the mainland of Alaska on the ice with which Bering Sea is filled during winter. The caves and subterranean passages left by the volcanic upheaval furnish the foxes with homes.

In summer the bird life furnishes an abundance of the choicest fox food. When the birds depart in the fall fox food consists of drift from the beach and the bodies of seals or sea lions which have either been killed, or died the preceding summer. This was ample until 1890, when the lessened seal and sea lion catches reduced the winter food supply and many of the animals died of starvation. The dead were eaten by the survivors, and the death rate in consequence was not noticed.

Since 1896 all seal meat not used by the natives on St. George Island has been salted and the following winter freshened and fed to the foxes. The seal meat, being insufficient in quantity, has been supplemented by dried or salt fish.

Coincident with the regular feeding begun in 1897, the old methods of trapping were abandoned. These consisted of death traps, so called, and steel traps, and a method of taking foxes from their warrens. The method of trapping now in vogue consists of capturing the animals in a large cage, in which the food intended for them is placed. Upon capture, the animals are subjected to a rigid examination and all undesirable ones are killed forthwith. Males left for breeding purposes must weigh at least 10 pounds and females at least 7½ pounds, and be either young or in the prime of life. In taking the live weights a strap is looped around the tail and the beast suspended from a spring balance attached to the ceiling of the building. The age is determined by an examination of the teeth. This is done by inserting a soft gag in the mouth and inspecting the teeth at close range. Those dismissed as breeders are branded by cutting a ring in the fur of the tail, males being branded near the end, females near the base. The men handling the foxes use heavy leather mittens.

On post-mortem examination of the animals killed in trapping the stomachs are found to carry in addition to the bait taken in the trap, grass, feathers, wild parsnip, fish bones, bird or seal bones, dirt or sand, and occasionally tunicates, sea eggs and fox fur. The intestines vary between six and ten feet in length, and were found to carry grass, feathers, wild parsnip, dirt, gravel, bones and sometimes tunicates and fox fur.

The bulk of males weighed between 8½ and 13½ pounds. That of females between 6 and 11½ pounds. Male skins when ready for market measure on an average 30 inches in length, 11 in breadth; the females are about one inch shorter and an inch narrower. The tails of both sexes are about the same length, viz., 15 inches. As a rule the fur of the female is inferior to that of the male, and among the males the best fur is found on the two- and three-year olds.

The breeding season is confined to March and the first half of April, and the young are born in litters of from five to twelve, in May and early June. Birth is given on the surface of the ground, but shortly afterwards the mother transfers the young to some place under ground, from which they do not emerge until several weeks old. While the birth rate is large, the infant mortality is very great, as only about two per female, on an average, reach maturity. They are born blind and weigh about 2½ ounces each. The eyes open on the fifteenth day, by which time the head and the tail take on a fox-like appearance. The teeth come through at or shortly after this time.

Occasionally one white fox is found in a litter of blue. Since 1897 a continuous effort has been made to exterminate white foxes, and results indicate that in time this will be accomplished, or at least that the white strain will be reduced to a minimum.

Evidence of diseases is scanty. Two cases of tuberculosis, one of uremic poisoning and thirteen cases of mange have been discovered. From the evidence at hand the males seem better able to

survive adverse climatic or other conditions than the females.

It is generally thought the animals pair for breeding purposes, but there is only one authentic case of paired foxes jointly engaged in feeding and guarding the same litter of young. The different methods of branding have shown that foxes often seen playing together in the spring are of the same sex. There have been six cases of promiscuous sexual intercourse witnessed.

It is customary on St. George Island to have 250 pairs for breeding purposes annually. After the breeding quota is secured all unbranded animals coming into the trap are killed and their skins secured. The annual yield of skins varies between 400 and 500.

On St. Paul Island, where artificial feeding was not attempted while a sufficient nucleus remained, fox life is almost extinct.

The Law of Recombination in Second Generation Hybrids: W. J. SPILLMAN.

It was pointed out that Mendel discovered three important laws: namely, the law of dominance, the law of separation and the law of recombination in the second generation.

The first two laws have been adequately recognized by most breeders, but the third law, which is by far the most important from the standpoint of breeding practise, has not been sufficiently emphasized. The law of recombination may be stated thus: In the second generation of a hybrid there tends to appear every possible combination of the original parent characters, the proportion of the population constituted by each type being $2^m/4^n$, in which m is the number of characters with reference to which the type is heterozygote and n the total number of characters involved in the cross.

It was pointed out that in practise the application of this law is limited:

1. By the number of individuals in the second generation, which must be numerous enough to permit the types to occur under the operation of the laws of chance.

2. The hybrid must be fertile.

3. The presence of cryptomeric factors may give unexpected results.

4. Non-Mendelian characters would be independent of this law.

5. In some crosses, such as produced Burbank's Primus berry, irregularities in mitosis might counteract the application of the law.

The recent work of Professors Price and Drinkard on tomato hybrids was given as an illustration of the recombinations of original parent characters, each of the eight possible types being shown. Illustrations were given of polled Hereford cattle produced by crosses between horned Herefords and polled Durham cattle. The application of the law of recombination at the Washington State Experiment Station has resulted in the production of a winter club wheat which is now rapidly replacing the spring clubs of that section. These wheats yield considerably more than the common wheats of the section and are worth more for flour-making purposes.

The Lewis and Clark Cavern National Monument of Montana: V. K. CHESNUT.

The speaker exhibited lantern slides illustrating the features of great geologic and historic interest. The cavern which is remarkable on account of the great diversity of form, and the snow-white beauty of its drip rock, especially the helictitic forms, is a steep comparatively unexplored abyss in an isolated earth-block of Madison limestone very closely bounded on two sides by faulting planes of profound depth separating it from the Belt formation and the Three Forks shale. Including the various halls, grottoes and chambers already discovered it is about a mile in length, the largest single room being about 125 feet in diameter with supporting columns one to three feet thick running up to twenty feet in height. No excavation has been made for vertebrate fossils. The limestone itself is made up largely of blastoid stems.

Of the existing living forms the only specimen taken of unusual importance was a single phalangid spider, which has been credited recently by Professor Nathan Banks as the type of a new genus, *Cyptobunus*. The cavern, being 1,600 feet above the Jefferson River at Limespur, overlooks 75 miles or more of the Lewis and Clark route along the Jefferson and Gallatin rivers and hence it seemed appropriate that the cavern should be conserved forever a monument to the memory of these intrepid explorers. The proclamation creating it a national monument was made under the act of June 8, 1906, entitled "An Act for the Preservation of American Antiquities" and was signed by President Roosevelt on May 11, 1908.

M. C. MARSH,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 430th regular meeting was held March 2, 1909. A preliminary presentation and explana-

tion was made by Mr. C. H. Robinson of a number of pieces of pottery, principally from Alamakee County, Iowa. Afterward the president of the society introduced Mr. Charles F. Warren, of the Bureau of Labor, who delivered a lecture of popular character on "Mexico, Its People and Customs," illustrated by colored slides. In the course of this lecture Mr. Warren touched upon the cathedrals, public buildings, gardens, markets and characteristic customs in Mexico, Cuernavaca, Puebla, Guadalajara, Guanajuato, Oajaca and other places, gave some fine views of the ruins of Mitla, and some superb examples of Mexican scenery. Finally a word was added regarding the passing of the old Mexican life and the coming of the new under President Diaz.

The 431st regular meeting of the society, March 16, 1909, was devoted to an address by Professor William H. Holmes, chief of the Bureau of American Ethnology, on "Outlines of South American Anthropology." Professor Holmes had just returned from the Pan-American scientific congress at Santiago, Chile, which he attended as special representative of the Smithsonian Institution.

He introduced his remarks by a brief sketch of the congress itself, and illustrated the journey by numerous water-color drawings. An outline of the geological development of the South American continent and the evidence of the presence of man during the Tertiary and Quaternary times were given. The tribes of the great Andean highland and their remarkable culture were described, and contrasted with the peoples and cultures of the lowlands. The wonderful progress made by the Incas, Aymaras and Chimus was illustrated by a large number of lantern slides.

Mr. W. E. Safford, of the Bureau of Agriculture, added some particulars gathered during his own sojourn in South America.

John R. Swanton,
Secretary

The Philosophical Society of Washington

The 662d meeting was held on March 13, 1909, Vice-president Wead in the chair.

The following paper was read by invitation:

Balloon Voyages and the Use of Air Currents: Mr. H. H. Clayton, Meteorologist of the Blue Hill Observatory.

The balloon was invented about one hundred and twenty-five years ago, and at first was of scientific interest only, being early employed by the English for meteorological observations. The Germans were the next to make use of it for similar investigations.

The use of sounding balloons equipped with self-recording instruments, the methods and the results obtained with them over land and ocean areas in different regions of the globe, were discussed at some length. The results show that in the upper regions in temperate zones the trend of the air currents is easterly, while in the equatorial regions they are to the westward. In all the regions of the globe so far investigated inversion of temperature takes place at an altitude of nine miles or so; this occurs at all times of the night as well as the day, and the inversion is found to be somewhat more marked in the equatorial regions than elsewhere.

An interesting account was given of the voyage of the successful balloon in the Gordon Bennett international balloon race from St. Louis in 1904, in which the speaker was one of the invited participants. It was pointed out how the knowledge of the circulation of the upper layers of the air was utilized in making this balloon voyage of forty hours' duration to the Atlantic coast. A number of lantern slides were exhibited illustrating this voyage, and two subsequent ones which the speaker had made. It was the speaker's belief that the knowledge of air currents is destined to play an important part in the ballooning of the future.

R. L. Faris,
Secretary

The Elisha Mitchell Scientific Society of the University of North Carolina

The 181st meeting of the Elisha Mitchell Scientific Society was held in the main lecture hall of Chemistry Hall, Tuesday, 7:30 P.M., February 9, 1909.

Professor W. C. Coker described a visit to Luther Burbank in his California home, illustrating his address with lantern slides and numerous specimens of Burbank's productions.

The 182d meeting was held in the main lecture hall of Chemistry Hall, Tuesday, March 9, 1909, 7:30 P.M. The program was as follows:

Professor D. H. Dolley: "The Pathological Cytology of Surgical Shock: I., Preliminary Communication—The Alterations occurring in the Purkinje Cells of the Cerebellum."

Professor A. H. Patterson: "Exhibition of a Series of New Vacuum Tubes."

Alvin S. Wheeler,
Recording Secretary